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ART. XVI.—*On the Velocity of the Galvanic Current in Telegraph Wires;* by B. A. GOULD, Jr., in a Report to Prof. A. D. BACHE, LL.D., Superintendent of the U. S. Coast Survey.

(Concluded from page 89.)

THE remaining questions to which I propose to apply the results of the Washington and St. Louis experiment, are—

1st. Whether the stations on the line received the signal pauses successively in their order of distance, and after intervals directly proportionate to their distance from the place where the signal was made.

2d. If the first question be decided in the affirmative,—by what route the signals reached the several stations; whether they were communicated through the earth, as Mr. Walker believes, when the distance between the stations is less by the earth's surface than through the wires, and if so, with what velocity; or whether they uniformly traversed the wires, and if so, with what velocity.

3d. Whether the intensity of the current occasion any appreciable difference in the velocity,* or whether the interposition of a battery between two stations affect the velocity appreciably.

In all the measurements for the determination of velocity, I have used the electrotomes only, and the results are thus entirely independent of the pass-time of the main circuit.

The Pittsburg and St. Louis registers are both very indistinct, owing partly to want of distinctness in the impression of the

* Fechner Repert. ii, 407. Poggendorff, Annalen, lii, p. 497. De la Rive, Archives de l'Electricité, i, 533.

graving tool, and partly to the bad quality of the paper of which the fillet is made. The Pittsburg register is in many places illegible owing to the shortness of the pass. This could be spared with less inconvenience than any one of the others, but it is a very unfortunate circumstance that the St. Louis record, the most important of all, should be so indistinct. It is affected, moreover, with the additional disadvantage, that the motion of the fillet was slow, and the liability to error in measuring thus greatly increased.

The labor of measuring off the intervals on the fillet is great and very tedious, and the average error of reading amounts to some hundredths of a second, although the intervals were mostly measured with dividers and a metallic scale, not with a diagonal scale of horn.†

All the results adduced depend upon the mean of a great number of readings, more than 5000 measurements of the work of February 4 having been made, in order to obtain them. The probable error has been computed in each case and indicates the extent to which they are reliable. The corresponding minutes are recognized without difficulty by the pencilings made on the fillet at the time by the operators; but the part of the fillet corresponding to the time of winding up the weight, which moved the registering apparatus, was not always noted, an omission which it may readily be supposed has occasioned much annoyance.

To estimate the length of wire between the several stations, ten per cent. has been added to the distances given in the books of reference. This is, I fear, too small an allowance for the sagging and zigzag course of the wires, but may be used in the absence of positive knowledge on the subject, and gives the following distances for the several stations as measured on the wire.

Washington,				
288	Pittsburg,			
622	334	Cincinnati,		
747	459	125	Louisville,	
1045	757	423	289	St. Louis.

The experiments occupied a period of several hours, the Seaton clock graduating the scale, at Seaton-station, Washington City, Pittsburg, Louisville, and St. Louis. The operator at St. Louis gave arbitrary signals by breaking circuit from time to time, at intervals of two or three seconds, which signals were recorded at all the stations. This he did for two successive minutes, twice during the evening. The same was done by the operators at Louisville, Cincinnati, and Pittsburg. Signals were also made at the latter station for ten minutes after the Seaton battery was

† Proc. Amer. Assoc., 1849, p. 189.

removed from the part of the circuit between the clock and the ground, and interposed between the clock and Pittsburg.

The number of measurements used to obtain the mean difference of the registers is so large that the addition or subtraction of fifty consecutive measurements exerts no appreciable influence on the result.

We have seen that when the clock-pauses are made at Washington and the arbitrary signal-pauses at St. Louis, the difference of the interval between the pauses on the registers of the stations corresponds to the time occupied by the current in traversing *twice* the distance between the stations,—the clock-pauses being recorded later and the signal-pauses earlier at the signal station, by the same amount. The same is true of intermediate places, the excess of the recorded interval at the clock-station being greater by an amount equal to twice the distance between the stations whose fillets are compared, divided by the number of miles traversed by the voltaic current in a second.

Let us now consider the effect of a signal not made at a terminal station, but at some intermediate one. For all places beyond this, the two pauses occur later than the corresponding one at the signal-station, by the same interval. So that the decrease of the recorded interval on the registers of the successive stations measures the velocity for twice the distance from Washington, until we reach the station where the signal was given. But for all places beyond this signal-station, the interval remains the same, and its record should be identical with that of the signal-station itself. We are thus enabled to control our estimate of the velocity between the clock and the signal station, by the records made at all the stations beyond.

I find the following to be the mean excesses of the intervals between the signal-pauses and the preceding clock-pauses on the Washington fillet, over those on the fillets at the other stations.

Washington Excesses.

Register.	Signals.			
	P.	C.	L.	St. L.
Pittsburg, ...	0·0295	0·0283	0·0373	0·0451
Cincinnati, ...	·0317	·0752	·0843	·0950
Louisville, ...	·0347	·0750	·1163	·1343
St. Louis, ...	·0455	·0704	·1108	·1451

Confining ourselves at first to the records of the signals made at St. Louis, we find the several registers to indicate the following velocities:

Pittsburg, . .	12772	miles in a second.
Cincinnati, . .	13095	"
Louisville, . .	11124	"
St. Louis, . . .	14404	"
Mean, . .	12851	

The agreement of these numbers, I consider very satisfactory. It will be observed that the velocity indicated by the St. Louis register is much greater than that derived from the others. Now the distance from Washington to St. Louis is 1046 miles by the wires, but only 742 in a geodetic line; and the question occurs very naturally whether this apparently greater velocity may not be a consequence of the transmission of the signal by the shorter part of the circuit through the ground, rather than along the wires. The distance to Louisville by the wires is 747 miles, and if the signals are transmitted through the ground to St. Louis with the same velocity as through the wire to Louisville, the time of transmission would be the same for both places. The results of measurement in these experiments show that a longer time was required for the signals to reach St. Louis than Louisville; though the greater length of time does not appear to have been proportionate to the greater distance. Those who believe the signals to be transmitted through the earth (when this distance is shorter), explain both these circumstances by assuming, what is very probable, that the velocity in the ground is different from that in the wire. The data of our experiment would furnish everything necessary to decide this question, did the measurements accord sufficiently well with one another. But when it is remembered that we are dealing with such quantities as hundredths and thousandths of a second, measured too by dividers and a metallic scale, on paper of different qualities, whose hygrometric contractions and expansions are not only very great, but unequal,—we cannot expect any very close accordance, in the results of different measurements.

Giving the other data more in detail, and determining the probable errors of the means by the method of least squares, we have,

St. Louis Signals.

Register.	No. obs.	Interval.	Prob. error.	Velocity.	Min. limit.	Max. limit.
P.	37	0″·0373	0″·00267	15442	14410	16633
C.	46	0 ·0844	0 ·00148	14748	14494	15012
L.	46	0 ·1163	0 ·00149	12846	12684	13012
St. L.	36	0 ·1108	0 ·00173	13484	13276	13698

Louisville Signals.

Register.	No. obs.	Interval.	Prob. error.	Velocity.	Min. limit.	Max. limit.
P.	56	0·0451	0·00252	12772	12096	13527
C.	60	0·0950	0·00302	13095	12691	13525
L.	65	0·1343	0·00252	11124	10919	11337
St. L.	61	0·1451	0·00329	14404	14085	14738

Cincinnati Signals.

Register.	No. obs.	Interval.	Prob. error.	Velocity.	Min. limit.	Max. limit.
P.	32	0·0283	0·00459	20400	17513	24294
C.	32	0·0752	0·00486	16543	15534	17685
L.	32	0·0750	0·00489	16587	15571	17744
St. L.	26	0·0704	0·00442	17670	16627	18854

Pittsburg Signals.

Register.	No. obs.	Interval.	Prob. error.	Velocity.	Min. limit.	Max. limit.
P.	44	0·0295	0·00154	19525	18557	20601
C.	36	0·0317	0·00233	18170	16926	19612
L.	37	0·0347	0·00258	16591	15451	17922
St. L.	10	0·0405	0·00249	12659	12003	13392

Classifying these according to the stations whose distances are measured by the recorded values.

Stations.	Mean Interval.	No. obs.	Ded'd Velocity.
Pittsburg.....	0·03567	152	16147 miles per second.
Cincinnati.....	0·08289	196	15008
Louisville.....	0·12291	147	12155
St. Louis.....	0·14510	61	14404

The combination of all these, according to the method of least squares, gives, as the result of the experiments of Feb. 4, a velocity of 14900 miles, with a probable error of the mean $= \pm 10$.

These last tables seem to answer conclusively the first of the questions just propounded,—and at the same time to suggest the second. We are justified in assuming that the signals, given by making and breaking the galvanic circuit of the telegraph, reach the several stations successively in their order of distance, and traveling with a finite and measurable velocity. But do they reach the terminal station *through the wires* first, when the distance through the ground is shorter?

Were the arrangement of the telegraph such now as it was at first, one source of uncertainty would perhaps have been avoided in the experiments; but the opportunity of solving this latter problem would have been lost. Until telegraphers availed themselves of the discovery of Steinheil, that no control over the circuit was lost when one half of it was formed by the earth, each telegraph line was double—consisting of one wire to the terminus and another back. But in all the lines in use in this country, the earth forms one half of the circuit. Are we to consider, when the two distant extremities of a line of wire communicate with the earth at a distance of many hundred miles from one another, that there is a special line of tension through the earth from one extremity to the other? and that a signal is communicated from terminus to terminus through the ground, in the same manner as it is through the wire? or may we consider the earth as a huge receptacle, to speak metaphorically, capable of receiving or imparting any amount of electricity at any time? The former opinion is held by my friend Mr. Walker.

But does it not seem improbable that the slight activity of a galvanic battery, traversing a circuit of 1000 miles of wire, should be sufficient to establish a *special* line of electric tension extending through the earth in a cord or parallel with the surface for 750 miles? For my own part, when I remember not only the

grand phenomena of terrestrial magnetism,* but the immense galvanic force which must† be exerted by the mutual influence of the huge masses of metal in the bowels of the earth,—when I consider the mighty electrical activity developed‡ in the great processes of nature,—I will confess that I can not bring myself to believe that *one special continuous line* of electric tension in the ground between two remote stations can be established athwart all these colossal forces by the action of a puny telegraph battery.§ Still, any views must be presented with diffidence, which vary from the expressed opinions of some of the greatest of our scientists.

The view which I take appears to be corroborated by the Coast Survey experiments of Feb. 4, in a two-fold manner.

First, if we suppose the clock-signals, starting simultaneously from the Seaton Station in two directions, to be propagated both through the wires and through the earth to the terminus at St. Louis, we must assume one of two things:—

1. That the signal which traverses the ground, moves with a velocity bearing precisely the same ratio to that through the wire, that the distance by one route bears to the distance by the other. This would be almost infinitely improbable, had we only the St. Louis experiment to guide us. But we have the results of the Coast-Survey experiments to Cincinnati and to Charleston, which prove this hypothesis to be incorrect.

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* Faraday, Researches, ii, p. 151. † Phil. Trans., 1830.

‡ Pouillet, Ann. de Chim. et de Phys., xxxv, p. 414; Becquerel, Traité, iv, pp. 164, 188; Bibliotheque Univ., xiv, pp. 129, 171; Faraday, Researches, ii, pp. 47, 93.

§ I say *special* line of tension, meaning by this a line, whether independent or resultant, which is capable of conveying electrotome and electropera signals in the same manner that a wire conveys them. After the admirable analytical investigations* of Smaasen, and the corroborative though independent researches† of Ridolfi, the character of conduction through the earth can no longer be doubtful. According to Baumgartner's experiments,‡ the earth's resistance to conduction of the voltaic current would appear dependent in great measure upon the geological formation of the localities traversed, as his attempts to measure the earth's conductive power gave very different numerical results in different directions from Vienna. Baumgartner infers from his experiments that the curved lines traversed by the current between the electrodes do not diverge so much as the researches of Smaasen and Kirchhoff ‖ would lead us to suppose. But are not his experiments exposed to the criticism, suggested § by Smaasen, that we must know the precise polarization of the plates before we are warranted in forming any inference as to the earth's resistance. Any attempts to infer the conductive power of the earth from the coast survey experiments of 1849, Jan. 23 or Oct. 31, or of 1850, Feb. 4, Feb. 5, or July 8, by assuming that the earth conducted telegraphic signals, would assign to the earth a smaller conductive power than that of iron wire,—a result in the most direct contradiction to the experiments of Jacobi,** Matteucci,†† and Baumgartner.

But if we assume that the earth can under the most favorable circumstances conduct signals as a wire does, this assumption vitiates the experiments of Mitchel,‡‡ and of Fizeau and Gounelle.§§

* Pogg. Annalen, lxix, p. 162, et seq., lxxii, p. 435.

† Il Cimento, 1847, May, June. v. Pogg. Annalen, lxii, p. 449.

‡ Sitzungsbericht d. Wiener Acad., 1849, May 10, July 5.

‖ Pogg. Annalen, lxxii, p. 497; lxxv, p. 189. § Pogg. Annalen, lxxii, p. 448.

** Pogg. Ann., lxviii, p. 483. †† De la Rive, Archives de l'Electr., xvii, 157.

‡‡ Astr. Jour., i, p. 43. §§ Comptes Rendus, xxx, p. 437.

2. We may suppose the velocity through the earth to be so small, that the electrotome after a passage of 742 miles through the earth has not reached St. Louis until the whole signal-pause and electropœa have been transmitted through the wire 1049 miles. On this theory, the passage of the 742 miles through the ground would occupy more than a quarter of a second, and we can not tell how much more.

The second argument in support of my view is also derived from experiment, and although not consisting of so direct a negation as the first, partakes of the nature of a *reductio ad absurdum* in a sufficient degree to be perhaps yet more convincing than the former. It depends on the comparison of the records of signals made at St. Louis and at the nearer stations.

If we assume that the signals between Washington and St. Louis were transmitted through the earth, it is easy by the comparison of the Louisville and St. Louis fillets to determine the velocity of propagation in the ground. The St. Louis register gives, on the assumption above made, a velocity through the earth which would make the time of transmission for 742 miles between the termini equal to that required for traversing 528 miles of the wire. This amounts to the same thing as if the current between the termini traveled with the same velocity as in the wire, but through a distance of only 528 miles. For convenience of expression, I will speak as though this were the case. The result would be precisely the same.

We have then, on comparing the different registers, two kinds of cases—one in which the distance between the stations is shorter through the wire, and the other in which it is shorter through the ground. We deduce the velocity for the latter instances on each hypothesis—and then inquire which best accords with the velocity computed from those cases where both hypotheses would give the same result.

The following table furnishes the materials for this comparison. The first hypothesis is that the signals traversed the wire alone; the second that they traversed the shorter route through the ground. In one column are the relative distances on each hypothesis;—in the other the deduced velocities. I infer from the discrepancies in the deduced velocities, that the improbability of the second hypothesis is exceedingly great.

Signal.	Register.	Relative Distance.		Corresponding Velocity.	
		Hyp. I.	Hyp. II	Hyp. I	Hyp. II.
St. L.	P.	576	59	12800	1311
P.	St. L.	576	59	10473	1073
St. L.	C.	1244	727	13097	7651
C.	St. L.	1244	727	17771	10386
St. L.	L.	1494	977	11405	7458
L.	St. L.	1494	977	13484	8817
St. L.	St. L.	2090	1055	14415	7283

All the results of the experiments made by the Coast Survey for the determination of the velocity of the galvanic current, have been most kindly placed at my disposal by my friend Mr. Walker to whom you had confided the entire direction of the work. These furnish the materials for a series of tables, containing the deductions from all the experiments. Collecting in one table all the cases where the current must have passed through the wires, and in another all those instances where the ground furnished part of the shortest circuit, we have two equations with two unknown quantities, viz., the velocity in the ground and in the wires. Determining the latter independently, we find the velocity deduced from all those cases where the distance is shorter through the wire, to be, by twenty-six different comparisons dependent on 768 readings, 15600 miles a second. Substituting this value in the other equation, we obtain the number of miles of wire to which the time of transmission corresponded. These equations may be formed by aid of the method of least squares. The discussion of the results of all the experiments of the Coast Survey, namely, those on the lines from Washington to Cambridge, Washington to Cincinnati, Washington to Charleston, and Boston to New York, show that the assumption of a transmission through the ground, with a constant velocity, does not materially improve the accordance of the observations. Indeed, in the experiments of February 4, the only indication of a transmission through the ground is to be found in the fact, that the velocity derived from the St. Louis observations can be made to accord better with the mean of the other values, by assuming that the signals traveled 1030 miles instead of 1045. The probable error of our estimate of the length of the wire is much greater than this.

The cases depending on 920 measurements, in which the shortest route is through the ground, are twenty-two in number. The velocity deduced, on the assumption that the signals traversed the ground, would be 11,200 miles in a second.

From all these considerations I infer that in the St. Louis and Washington experiments which were, of all that have been made, the most favorable for exhibiting the phenomena,—the signals were in no case transmitted through the ground.

We have thus endeavored to take account, as far as possible, of all the sources of error which cannot be avoided, and to escape all those which can. Our results, obtained from different data, accord so well with one another as to make it appear very improbable that the velocity of the propagation of the electric state produced in the telegraph wires by a galvanic battery is more than 20,000 or less than 12,000 miles per second.

From the combination of all the Coast Survey experiments with the electro-magnetic telegraph I have endeavored to deduce a measure of the velocity which shall be as reliable as the nature

of the case permits. The difference of temperature, at stations so distant from one another, makes it appear unadvisable to introduce any correction for temperature, even were such a refinement of the same order of magnitude with the unavoidable errors of our measurements, and therefore congruous with their character. The temperature was, in all cases, as low as the freezing point—the insulation not being sufficiently perfect at other times to allow communication between very distant stations. The distances used are the following, in miles—ten per cent. having been added as before.

Washington,			
172	Philadelphia,		
381	209	New York,	
850	469	260	Cambridge.

Washington,			
74	Harper's Ferry,		
165	91	Cumberland,	
309	235	144	Wheeling,
578	504	413	269 Cincinnati.

Washington to Cambridge, through the ground, . . 380
Washington to Cincinnati, " " " . . 403

The great length of wire assigned to the part between New York and Philadelphia is a consequence of the distance to which the line ascends the Hudson before finding a crossing-place.

Date.	Terminus.	Velocity.	Prob. error.
1849 Jan. 23,	Cambridge,	18000	150
" Oct. 31,	Cincinnati,	18350	124
1850 Feb. 4,	St. Louis,	14900	10
" Feb. 5,	Charleston,	16856	

The resultant is 15890 *miles per second, as the most probable value.*

Mr. Walker's experiment, 1850, July 8, with the Electro-chemical Telegraph,* gave for the velocity between Boston and New York (220 miles) 13333 miles a second. The wire of Bain's Telegraph is however of a different size from the other lines, and is coated over to prevent oxydation. Should we assume the signals to have been transmitted through the ground, Feb. 5, and July 8, we should obtain the respective velocities 10690 and 10820 miles per second.

In spite of the mutual confirmation of the several results by one another, and although the accordance is even remarkable, considering the numerous obstacles and sources of error, it is nevertheless true that the observations might be still better represented by supposing the velocity to be different at different parts of the line. Is this assumption admissible? It is, if we have reason to suppose that the velocity is dependent on the intensity of the current—for several batteries were interposed at intermediate stations on the line. The most powerful battery was at Pittsburg, consisting of fifty Grove's cups, each holding a pint. The comparison of the different velocities appears to indicate that

* Ast. Journ., i, p. 105.

the greatest velocity of propagation was between Pittsburg and Washington, and Pittsburg and Cincinnati, but I am not disposed to lay stress on this point. In order to determine whether the velocity of the current was the same, when a battery was interposed between the signal and registering station, Mr. Walker made, as has been said, a special experiment. by continuing the Pittsburg signals for ten minutes after the Washington battery had been changed from between the ground-connection and the clock, to part of the circuit between the clock and Pittsburg. The difference between the times of transmission given in the two cases, is so small as to be practically inappreciable, and probably owing to the unavoidable errors of reading.

Eight measurements on the Pittsburg and Cincinnati registers, where the battery was not interposed, gave as the time of transmission from Washington to Pittsburg $0^s{\cdot}03049$. Seventy-four measurements on the same registers when the battery was interposed gave this time of transmission $0^s{\cdot}03106$.

Yet this does not furnish an answer to the question, whether the velocity is a function of the intensity of the current; for this intensity can hardly be varied by a transfer of either the circuit-breaker or the recording apparatus to the other side of the battery.

I have taken no account of time requisite for the development of the galvanic current,—inasmuch as, according to the experiments of Jacobi,* this time must certainly be a quantity of the second order when compared with the time requisite for the propagation of the electric force along 1000 miles of iron wire.†

There are several cases in which the line separating the clock-pause from the signal-pause precedes the clock-pause on the St. Louis register and follows the corresponding one on the Washington registers. This was first discovered by Mr. Walker, who considers‡ it to indicate that waves caused by breaking and closing the circuit may travel in opposite directions and cross one another, without interference. This view is theoretically startling to those who have looked on electric phenomena as exhibitions of a polar force, and I have examined with great care all the cases of this kind which could be found. In none of them can I find the distance between the signal-pauses on the two fillets to correspond, even approximately, to the velocity which the comparison of the same fillets indicates. The interval is generally twice as great as would be due to the time of transmission. I have been compelled to look in a very different direction for the explanation of the phenomenon. The St. Louis operator often struck the break-circuit key twice in quick succession; and in the cases under discussion, it would appear that the interval between these two consecutive signal-pauses was very nearly equal to the time

* Pogg. Ann., xlv, 23.
† Haldat, Comptes Rendus, vi, 52. De la Rive, Arch. de l'Electr., iii, 288.
‡ Proceedings Amer. Assoc., Charleston, 1850, p. 124.

of transmission between St. Louis and Washington, and that one of the signal-pauses was confounded with the clock-pause at St. Louis, and the other with the clock-pause at Washington.

Two circumstances tend to corroborate this view.

1. The length of the clock-pause is in all these cases greater than the average; and

2. The interval between the clock and signal-pauses is neither too great nor too small to correspond with this hypothesis.

There are several other points which I would gladly have discussed; but will however confine myself to the mention of a single curious fact. Reducing the velocity found by Wheatstone for friction-electricity in copper, by multiplying it with the ratio of the conductive power of the two metals, we have 51096 as the corresponding velocity in iron wire of the same diameter (1·75 millimeters), at a temperature of 32° F. This is to the velocity we have deduced, almost precisely in the inverse ratio of the sectional areas of the conducting wires.

It is to be hoped that still farther materials may be collected during the ensuing winter by the zeal of the Superintendent of the Survey, and the indefatigable energy of Mr. Walker. The superior insulating power of the posts in freezing weather, renders winter the most desirable season for instituting experiments of this kind. It is a circumstance in which we as Americans may be warranted in feeling an honest pride that all the telegraph-experiments, excepting those of Mitchel and Fizeau, which have been instituted for deducing the velocity of the galvanic current —a result so important to science, and for the proper discussion of telegraph-observations for longitude—have been made under the superintendence of the U. S. Coast Survey.

In future experiments it appears to me highly desirable that some machinery, capable of delivering several inches of paper per second, at a tolerably uniform rate, should be employed to move the fillet or cylinder on which the record is made; that the quality of the paper used should be as fine as possible, and that the adjustments of the pass and spiral spring should remain unchanged during the continuance of the experiment. Farther experiments with Bain's Chemical Telegraph are desirable, if means can be devised for recording at each extremity of the line, by one and the same circuit, which is not improbable.

The ordinary size of the telegraph wires is, as I understand, that corresponding to a weight of about 300 lbs. to the mile. The new line now constructing, by the patentees of House's wonderful printing telegraph, between Buffalo and New York, is composed of wires weighing from 600 to 800 lbs. to the mile. Experiments made with this line would be of great service in determining whether the velocity varies with the section of the conducting wire. Very respectfully yours,

Cambridge, August, 1850. B. A. Gould, Jr.

Art. XVII.—*Observations on the Gnathodon beds around the head of Mobile Bay;* by Rev. C. S. Hale.

The most striking feature of the low, flat region, which forms the northern coast of the Gulf of Mexico, and perhaps the only legitimate one for determining its place in the geological series, are the numerous Gnathodon beds scattered around its bays and deltas.

These remains have long attracted the attention of various individuals, none of whom, however, have favored the public with any results of their observations. Some few years since, an imperfect sketch of what had then been ascertained respecting these beds, was furnished to gratify the desire of a few particular friends. Since then, more extended and satisfactory researches on the subject have been deemed not unworthy of a greater publicity, as a means of extending the boundary of scientific knowledge.

These deposits are not altogether unique in their character: they may be considered as similar in their formation, if not contemporaneous with various others that have been noticed in different parts of the earth; and a reference to some of the latter by way of example, will not be irrelevant to the present design.

The first we shall name, occurs on the coast of Vendée near St. Michael. There are three eminences here, which are entirely composed of marine shells, at a distance of five or six furlongs from the sea, and at an elevation of about five yards above the highest tides. These masses consist of species actually living on the neighboring coast, such as Ostrea edulis, Pecten sanguineus, Murex imbricatus, Buccinum reticulatum.

Another has been observed on the peninsula of St. Hospice, near Nice: it is seventeen yards above the level of the Mediterranean. It consists of calcareous sand, including a large quantity of shells, but little altered, resembling those inhabiting the coast.

A thick bed of marine shells also occurs near Maïta, on a peninsula between the Hellespont and the Gulf of Laros; the species consist of Venus chione and cancellata, Solen vagina, and Cerithium vulgare; the same are still living on the coast. Masses of the same shells may also be seen on the coast of Asia opposite.

Similar instances are known in the island of Great Britain. Adanson makes mention of a large collection of marine shells on the Scottish coast, found near Loch Lomond, seven yards above the level of the sea. Another occurs on the bank of the Forth, likewise another near the Clyde. Each of these beds is elevated about four feet above the tide.

But some of the most remarkable of the shell masses have been observed in Sweden and Norway at an elevation far above the highest tides. The first is at Figa-elo in the northern part of Norway, said to be situated more than one hundred yards above

the level of the sea. Others occur at Tromose and Drontheim, at an elevation of only five or six yards.

Near the small town of Uddevalla, in Sweden, marine shells have been accumulated upon the shore to so great an extent, that from time immemorial they have been carted away for the purpose of paving the public ways. These are at an elevation of about sixty yards; the shells are like those in the neighboring sea; they are almost entirely exempt from earthy mixture.

Near Valparaiso in South America, about forty yards above the level of the ocean, there is a remarkable deposit consisting of a single species, the Concholepas, which is still living on the coast.

Whether the Gnathodon beds in question are to be classed with the preceding remains to be determined.

Of the genus Gnathodon, there are two living species on the American coast, the *Gnathodon cuneata* and *G. flexuosa*, both occurring about the Gulf of Mexico. These are estuary species, and inhabit brackish water; yet there are some apparent exceptions to this statement, owing to the prevalence of fresh water in certain cases; hence the inquiry becomes somewhat important, whether these molluscs can undergo such a change with impunity.

We cannot argue here from animals that are migrating like fishes, to those like mollusca that are stationary. It may be expected that the adaptations of the latter would be as limited as the requirements of the condition in which they are placed; and if this condition be liable to changes, fatal to the welfare of the beings thus situated, this is only of a piece with those contingencies in the general economy of nature, to which all beings are more or less subject in the way of catastrophe involving their destruction. Indeed, I am not aware that there is any known species of mollusc that is adapted to vary its condition in the manner supposed. It was once thought that the Mytilus edulis inhabited the Danube. But a more correct examination has since proved that, so far from being identical with the marine species, it belongs to a different genus (Dreissena).

It is not to be denied that the species, under consideration, is found in circumstances somewhat variable. Belonging to neither extreme, it may undergo a change of medium either more or less salt, or more or less fresh, without much apparent disadvantage. It may even exist for a time in water entirely fresh; still it is contended that no functional change has been produced to render it permanently a fresh-water species. It is more than probable that the deposits far in the interior, are composed of individuals that lived in the vicinity, and were coëval with the formation of those shell masses; and who can doubt their gradual destruction as the sea retreated to its present limits at the head of Mobile bay, where the species are yet found in circumstances congenial to their nature. An instance occurs in Maurepas lake where recent

orographic changes have rendered the water permanently fresh; but it is evident, the few hardy individuals that still live there, cannot long abide the effects of their unnatural situation.

But a more remarkable event in the history of the species is that of their entire destruction north of Florida. This phenomenon, considered as a rare effect of that more remarkable part of the economy of nature which determines the fate of whole species as well as that of individuals, renders this part of our subject particularly interesting. It likewise suggests the importance of more extended observation respecting what relates to the species in this portion of their former geographical range—such as the condition of their remains, and the various other circumstances peculiar to these localities; also the other organisms that may be found imbedded with them;—together with those indications that may be discovered explanatory of the cause of their extinction; whether it be an alteration of climate, or some orographic change affecting the thermal influence of the gulf stream along the coast; or any other agency yet undiscovered.

What has already been ascertained concerning the adaptations of the animal may serve to throw light upon some of the circumstances in which the species is found, whether living or fossil. Their natural adaptation to an exposed situation in the loose mud, furnishes the reason why they are so generally found, either in the sinuosities of the shore, or the cavities of river channels, where the wind and the current may not disturb them. In addition to these considerations, their limited locomotive power, somewhat as in the case of the oyster, will, without the necessity of referring to any other special agency, natural or artificial, sufficiently indicate the cause why such large masses are found precisely in those circumstances, where they are actually presented to our observation.

These deposits will now claim our attention in a geological point of view.

The first consideration regards their position, which occurs in three very distinct varieties of circumstances, answering to as many successive periods in which they were formed. First, the submerged beds; next, those which are only partially submerged; finally, such as are entirely elevated above the water, at various distances from it, and at different elevations.

The submerged beds are not unfrequent around the head of Mobile bay. They have been observed more particularly in Raft river, where they occur in a very regular succession for miles, at a depth of fifteen or twenty feet. The various channels that intersect the extensive morass between the Mobile and Tensaw rivers, seem for the most part to be well adapted to the prosperity of the species in question; at least, this was eminently the case in a more remote period, for here are two of the most remarkable deposits, within the limits of our observation, one for its extraordinary superficial extent, the other for its height.

It is evident however that new masses of shells are still forming in the beds of these streams, in every respect similar to those which are found in elevated situations. These submerged beds also illustrate the method by which the others have been amassed to such a remarkable extent. The living part of the species are frequently liable to perish in becoming too deeply imbedded by an unusual increase of alluvium, a very common event in this delta region; the continued propagation of the species in such circumstances, admits of the continued increase of the mass to an indefinite extent. Superficial marsh-deposits are of no rare occurrence in the vicinity in which the shells are thinly scattered through a thick mass of black mud, clearly evincing that such was the way of their formation. It is not improbable that those elevated masses which occur free from such earthy mixture, existed originally in a similar mixed state, the drifting of the current, or the drenching of the rain, having divested the deposits of the more moveable earthy portion of their ingredients.

The partially submerged state of the next class of deposits, may be ascribed to several different causes. They may have been formed upon an inclined or uneven bottom, so as to have become but partially emerged in the process of their upheaval, or they may originally have been horizontal beds consisting of a large proportion of muddy alluvium, and at the time of their emergence, being but partially exposed to the river current, the earthy portion of the exposed part was washed away, leaving the unmixed shells in a submerged state along the shore. Or finally when the mass was elevated, some individuals may have continued to live and multiply by the shore, forming an apparent continuation of the original deposit.

The submerged portion of these beds may often be traced to a distance of many rods. They occur principally in insular and marshy situations, remote from the main land; particularly on Spanish and Raft rivers and around Grand and Polecat bays. When forming, they must have been at the bottom of a somewhat shallow, but extended bay, which afterwards became silted up, and perhaps partially elevated by means of subterranean action, and was since intersected by numerous rivers and creeks, as well as bays and lagoons, the desirable resort of various species of water fowls, alligators, &c.; and last though not least, of immense quantities of molluscs, the accumulated masses of whose remains are scattered at short intervals over the entire extent of this region.

The third class of beds consists of those which are wholly elevated above the water; they are principally situated on the main land, near the first terrace from the water's edge, at nearly equal elevations above the tide. They are usually of an oblong shape, their longest axis being parallel with the neighboring

shore. They mark the period of the last retreat of the water within its present more circumscribed limits. Their former submerged condition, must evidently have corresponded with that of those which are still found living in a littoral situation. The abrupt termination of these masses, without the appearance of any scattered remains in the interval between them and the shore, likewise the absence of living individuals in the neighboring water, will not seem surprising, when it is considered that the current, caused by the more contracted limits of the channel, must have prevented their continuous multiplication. There are however, some instances, where thinly scattered remains occur even to the water's edge, but such cases are found only in circumstances which are favorable for the continued existence of the species.

The beds of this class are generally two or three yards above the level of the tide. The foundation on which they rest resembles that of a submerged bottom, not that of an open bay,—rather like that of an estuary in the vicinity of rivers and inlets, where the siltings of fresh-water alluviums are not wholly excluded. Those deposits which occur on the Mobile and Tensaw rivers are evidently of a much older date than those already noticed in the intermediate space, which must have remained longer in a condition unfavorable for the propagation of the species.

That series of inland deposits west of Mobile bay, commencing at the northwest angle of that bay near Choctaw point, and extending northwardly to Twenty-one mile bluff, presents several important features; their dimensions manifest a gradual increase in advancing towards their northern limits, where some of the largest and most elevated masses are found; they also mark in a very striking manner, the former inland extent and shore-line of the present bay. It is also observable that the largest of these deposits usually occur near the outlet of some stream, where existed a favorable combination of circumstances for their increase, particularly the confluence of the fresh-water current with the ocean tide. Instances of a similar nature are presented along the borders of that chain of lakes, connecting with the Gulf of Mexico, and extending into the southeast section of Louisiana, especially the one which formerly existed at the mouth of Blind river, it is more than twenty feet high and six hundred yards in length.

Before proceeding to the examination of our last object of inquiry, the structure and contents of these beds, it will be proper to notice the distinction which ought to be made between certain effects of Indian agency, and those which are the result of natural causes.

It is evident that at some former period these shell deposits were objects of much interest to the aborigines. They seem to

have selected them in a special manner, as burying places for their dead—for this and perhaps also for some other reasons, they became places of resort, and the receptacles not only of human remains, but of various kinds of superstitious relics, spoils of hunting, also of various fragments resulting from certain kinds of artificial operations which they found convenient to practice in these places. The different sorts of objects here alluded to, have been distinctly traced, as they occur in the original mass of organic remains.

Human remains are somewhat abundant in certain deposits, but generally in a very broken state. Fragments of pottery are also common; they appear to have been manufactured on the spot, as they are partially composed of pulverized shells. Religious images, formed of the same materials as the former, have also been found to a limited extent. The occurrence of the Cardium, and especially of a large variety of Pyrula perversa, both marine species, inhabiting the gulf, seemed rather surprising, until it was ascertained that the natives make special use of these particular shells for the manufacture of ornaments for the neck. Coal and ashes must also have been produced by their fires; but the latter can seldom be detected, having disappeared by mixing with the shells, and the former is seldom distinguishable from the carbonized wood which abounds.

In regard to the opinion that these masses of shells have been formed entirely by the Indians, nothing can appear more improbable, if the circumstances of their existence are duly considered. It is not to be denied, that, in some instances, the natives might have brought living shells to these places for the purposes of food: indeed, it is highly probable, that those thinly scattered shells that are found near where living ones were easily obtained, may have been entirely the remains of their repasts; for these instances correspond precisely with those which occur in the interior, where the remains of the Unio and Paludina are thinly scattered along the banks of the rivers, but are never found in dense masses.

The following facts selected from many of like nature, may be presented as a refutation of the notion respecting Indian agency in the formation of the beds in question. There are none of the species, of which they are composed, to be found within a long distance of many of the largest of these deposits; and others, not a few, have their foundation several feet below the level of tide water, besides being situated in various other respects quite incompatible with the notion of human intervention, in the affair of their construction—such as partial submergence; the clear proofs of their natural stratification, and especially the general occurrence of immature and minute species, scattered through the mass, all which is quite unaccountable if considered as the effect of Indian labor.

There is a strange disposition manifested by many of our antiquarians to seek for the marvelous in whatever relates to the doings of our aborigines. In certain regions of the country, almost every trace of their former operations is by a hasty induction resolved into some astonishing display of their skill and industry. It is very amusing to witness the extent to which this sort of philosophizing has been carried in some parts of the continent where nature herself has so entirely preoccupied the ground, by throwing up an almost uninterrupted succession of ridges and mounds, as to leave scarcely the possibility for the employment of Indian enterprise in such operations, without encroaching upon her own domain. But through the entire length and breadth of the flat and level plain bordering the Gulf of Mexico, there happens to be no other means at hand for discovering the celebrity of its equally numerous and powerful aboriginal inhabitants, except the masses of shells, which unfortunately in this case can serve only as a proof of gastronomic ability.

A few facts in relation to the structure of these beds may now be noticed. Only the thicker masses, however, possess much importance in this respect; these contain intermixtures of various kinds of earths and other ingredients, indicating more or less clearly the circumstances under which they originated. Reference to a large deposit near the junction of Raft and Tensaw rivers, will furnish the best illustration of this particular, both in regard to its structure and contents, as it combines the principal characteristics of all these beds. It is nearly circular in form; the diameter of its apparent base is one hundred yards, but its real base, which is ten feet deeper, extending out at a distance beneath the soil, is one hundred and forty yards. The most elevated part of the mass, consisting of a ridge forming a chord line near its western limits, is from fifteen to twenty feet above the apparent base. From this ridge the surface gradually declines towards the eastern border where it thins out. The superficial part of the mass consists of shells and a mixture of dark colored earth or vegetable mould; then succeeds a series of strata composed of various ingredients besides the shells, such as sand, calcareous mixtures, several kinds of organic remains, principally those of fish, all of which are so arranged as to exhibit distinct signs of stratification. The following is a perpendicular section in the most elevated part of the deposit. 1. The superficial mass of vegetable mould already noticed. 2. A layer of shells almost free from mixture. 3. Another intermixture of dark earthy matter with shells. 4. Shells mixed with yellowish earthy matter. 5. A thick mass of sand and shells. 6. A thin seam of shells with a dark mixture, succeeded by rotten comminuted ones. 7. A deposit composed principally of very small shells. 8. A seam of dark colored earth, succeeded by another of a yellowish marly

nature, containing a smaller proportion of shells. 9. A thick mass of shells and sand. 10. At this stage, which approaches the level of tide water, a very marked change takes place in the features of the bed; instead of shells, earthy matter now becomes predominant, which here consists of yellowish sand, and other organic remains become less common. 11. Masses of red sandstone and conglomerate in a regular stratum, intermixed with sand and shells; dimension of the masses from the size of the fist to six inches in diameter. 12. Stratum of dark sandy marl, with a continued deficiency of shells and other organic remains. 13. A mass of comminuted shells with a little earth and a few entire well preserved shells. 14. The remainder of the section, extending only to the level of tide water, consists of a mass of well preserved shells, free from every species of mixture, a circumstance attributable to the percolation of the water through the body of shells, which having destroyed the other more perishable remains, became a preserving medium to the shells. This effect is very common in the thinner deposits; being more exposed when in a submerged state to the drifting of the current, and afterwards to the drenching of the rain, they become deprived of their less permanent interstitial ingredients.

A deposit near the mouth of Three Mile Creek, deserves mention in this connection. It is about four feet in thickness, rests upon a sandy base, and consists of a stratified mass of sand and shells. The part bordering upon the creek, which is in a low marshy situation, contains but few shells, imbedded in a deposit of black mud; the valves of many of these are united, and evidently in the position in which they lived; others are actually living in the bed of the creek. The whole presents a very interesting gradation in the series of geological events which have transpired between the remote past and the present time.

The large deposit on the southern terrace of Twenty-one Mile Bluff, furnishes another instance of regular stratification. It is covered with an unusually thick soil over the mass of shells, like that of the surrounding land, which must have been formed previous to the emergence of the original shell-bed above the surface of the water. The earthy alluvium was found to be abundantly diffused through the mass of these remains.

The organic remains that are included in these deposits have no doubt already been understood to consist almost entirely of a single species, the G. cuneatus. Their living characteristics have been noticed; they are now to be considered as fossils. But the various circumstances in which they exist often render the determination of their antiquity very uncertain from the sole examination of the shell. Their decayed state, in the superficial exposed part of a deposit, may give it all the appearance of an ancient formation; while those at the base, with the exception of the

loss of their epidermis, retain all the marks of recent shells. Their normal characteristics are generally to be sought where they are imbedded in earthy mixtures; the determinations of the relative age of those beds that are differently constituted, must depend upon other criteria.

An instance of the former kind is the interesting deposit at Twenty-one Mile Bluff. These remains have continued without disturbance in their alluvial deposit, as they were originally formed, until the present period. They have lost their animal matter, their external surface has become somewhat worn by the wasting influence of time, and a silicious incrustation has been formed in their cavities, exhibiting the appearance of an approximation to a petrified state. From these older deposits an evident gradation in effects of a similar kind may be traced in other masses answerable to the date of their formation as it approaches the present time.

There are also other organisms associated with the former, and though not numerous, they are more or less important as means to illustrate the history of these formations. Among these, the Cyrena of Carolina claims a particular notice; it is an estuary shell, and is usually associated with G. cuneatus, both living and fossil; and in both of these states it occurs in the same apparent numerical proportion. There are, however, some few deposits, especially such as are more elevated, (the one near the junction of Tensaw and Raft rivers is an instance,) in which the Cyrenæ are limited to particular sections; perhaps they are not adapted to every variety of circumstance in which the G. cuneatus may exist.

The Neritina reclivata is another species found in these deposits, but in various proportions in different beds, and in some they are entirely absent. In the one at Twenty-one Mile Bluff, the individuals occur in about the same numerical proportion as those of the G. cuneatus itself, while there are very few to be found in the large deposit, near the junction of Raft and Tensaw rivers. But it is a striking fact that at the present time, living ones abound in the vicinity of the latter, while the former is far beyond the limits of their present habitation. They are usually found living in calm, stagnant situations, attached to water plants and old sunken logs. In a locality of this kind, near Choctaw Point, they may be seen crawling over the bottom where the G. cuneatus still exists.

The few remains of other testacea found in these deposits, such as the Unio and Oyster, must have been introduced by methods more indirect. The former were probably transported from their more interior abode by means of the fresh water currents. But there is evidence that the latter perhaps in some accidental way were to a small extent generated upon the spot.

The residue of these remains belong to terrestrial mammals, birds, fish, and reptiles. The two former, consisting only of a few broken and rather indeterminate fragments in a somewhat superficial situation, may without impropriety be regarded as the spoils of hunting. But the next class, pertaining to fish, were undoubtedly, with very few exceptions, contemporaneous with the formations where they occur. For with the exception perhaps of a small portion of the superior part of the remains in question, they are scattered more or less abundantly through the entire mass in such a manner as to render it evident that they found their way there by no artificial process. For the exuviæ of each animal occur in separate and distinct masses, more or less complete,—scales, vertebræ and all.

In one instance no inconsiderable portion of the vertebral column of a large species was found deposited in a connected form in the interior of one of these shell masses, just as other analogous remains occur in ancient formations when they have not been exposed to disturbing causes.

Some of the species which have been obtained are of more frequent occurrence than others, and these are precisely the kind which might have been expected to be found with these remains, such as the Sargus ovis and an unknown species of Sparus (?). The strong pavement of palatal teeth which these fish possess enables them to feed on the Testacea in question, whose shells they crush with facility. Besides these, species of Perca, Breme, and a few others, are somewhat common; also vertebræ of the Lepisosteus ferox, already alluded to. Teeth of the Alligator Mississippiensis occur in a few instances. Also somewhat numerous remains of several species of Emys. In some of the large deposits, crab's claws have been found. All these, as far as ascertained, appear to be contemporaneous with the existing fauna.

The general absence of organic remains in the remaining portion of the region bordering on the Gulf of Mexico, renders its place in the geological series somewhat uncertain. The only organisms yet discovered consist of casts of Unios, so far as ascertained, belonging also to existing species, such as U. plicatus and circulus, the present inhabitants of our rivers; they were obtained from a locality sixteen miles distant from the head of Mobile bay, in a northwesterly direction, from an excavation made to a depth of thirty feet.

There are also considerable quantities of drifted alluvium, logs, &c., which have been discovered at various depths, both in the recent and more ancient alluvial deposits. But these lead to no very definite conclusion. And the subjacent sands and clays, so far as observed through the whole series, bordering upon the water courses, even to the outcropping of the white limestone, are equally destitute of organic distinctions. It is however very

probable that the sand and mottled clay formation, commencing as it does from the white limestone, was continued up to a period contemporaneous with the formation of the oldest Gnathodon beds, such as that at Twenty-one Mile Bluff, which evidently rests upon the last of the clay series. And from thence we have for data the succession of the shell formation in question, extending through perhaps the post-pliocene and alluvium period, exhibiting a pretty regular series of geological events, even to the present time.

ART. XVIII.—*On the Mineral Springs of Canada;* by T. S. HUNT, Chemist and Mineralogist to the Geological Commission of Canada. No. III.

IN two previous communications to this Journal, I have given descriptions and quantitative analyses of several mineral waters which had been described in the Annual Report of Progress of the Geological Survey of Canada for 1848–1849. The following are a continuation of the same series of researches and appeared in the Annual Report, 1849–1850. For the plan of analysis pursued, I refer to the previous articles which appeared in vol. viii, p. 364, and vol. ix, p. 266.

Varennes Springs.—These sources are upon the southern border of the St. Lawrence, about seventeen miles below Montreal, and rise through strata, which, though concealed by the tertiary clay of the valley, belong either to the upper portion of the Utica slates or the lower beds of the Loraine shales. They are pleasantly situated about a mile and a half below the church of Varennes, at the base of a little ridge which runs along at a small distance from the shore, and bounds a fine tract of meadow land. A century ago they were greatly resorted to, but of late years have fallen into unmerited neglect.

The springs, which are two in number, are very similar in their sensible properties; the outer spring, which is distant about a hundred rods from the house that encloses the other, is the one generally resorted to for drinking, and is called by the villagers by the way of distinction the "Saline," while the spring within the house, from the immense quantity of carburetted hydrogen which it evolves, is known as the "Gas Spring." Within about ten feet from this, is another well, but the water has the same level and temperature as the last, and is said to belong to the same basin.

The water in the outer well is about eight feet deep; it rises quite to the surface and is limpid and slightly sparkling; from

time to time a few bubbles of carburetted hydrogen are evolved. The flow of water from the spring is probably two or three gallons per minute; around the well, there is a slight deposit, ochre yellow on the surface and bluish green within, and the course of the spring is tinged of a yellowish hue for some distance. The water is saline to the taste, and has a very agreeable flavor.

The water of the inner spring is about five feet below the top of the well, which appears to be nearly on a level with that of the one previously described. It is kept in constant ebullition by the escape of large volumes of carburetted hydrogen gas, which is collected by a gasometer and employed for lighting the rooms above. The discharge is apparently about the same as that of the other spring; the water is saline to the taste and closely resembles that of the one before mentioned.

The temperature of the two springs is somewhat different; on the 18th of October, that of the outer well was 47°·5 F., and that of the inner one 45°·5; the air being at the same time 44°. I had before visited these springs on the 20th of November 1847, and found the temperature of the outer one nearly the same as above stated, 47° F., while the inner spring was 40°; the air being 19°. I was informed by the proprietor that the former spring, although not protected from the weather, never freezes to any extent, while the latter, although sheltered by the house, and so much below the surface, is filled with ice in severe weather. The escape of such a quantity of gas, which may be supposed to find its way into the spring below in a greatly condensed state, and be rarified in rising, may help to explain in part this difference: but it is conceived by the villagers that it is affected by the changes of the seasons, and is at the same time warmer in summer, a fact which I have, however, not yet been able to verify by experiment.

I. *The Outer Spring.*—This water has been already described as quite saline to the taste, and analysis shows the presence of a large quantity of common salt, with traces of a salt of potassium. The concentrated water is distinctly alkaline, from the presence of a small quantity of carbonate of soda; the lime and magnesia which are present are also held in solution as carbonates. In addition to these were obtained small quantities of bromine and iodine combined with the alkaline bases; traces of iron, alumina and silica, and the rare bases, baryta and strontia, which have never to my knowledge hitherto been observed in any of the mineral waters of this continent. The specific gravity of the water at 60° F., was determined to be 1008·15, pure water being 1000. One thousand grammes of the water yielded as follows:

	Grammes.		Grammes.
Chlorine,	5·777100	Lime,	·198240
Bromine,	·009790	Magnesia,	·259190
Iodine,	·004512	Protoxyd of iron,	·003000
Soda,	5·098500	Alumina,	*trace*
Potassa,	·077900	Silica,	·046500
Baryta,	·017500	Carbonic acid,	·920000
Strontia,	·007320		

These ingredients may be combined to give the following composition for 1000 parts of the water:

Chlorid of sodium,	9·42310
" of potassium,	·12340
Bromid of sodium,	·01265
Iodid of sodium,	·00541
Carbonate of soda,	·17050
" of baryta,	·02260
" of strontia,	·01400
" of lime,	·35400
" of magnesia,	·54432
" of iron,	·00480
Silica,	·04650
Alumina and phosphates,	*trace*
Carbonic acid,	·46914
Water,	988·80958
	1000·00000

The amount of saline materials present is by calculation 10·721. Direct experiment gave of residue dried at 300° F., 10 526 parts for 1000.

The quantity of carbonic acid in the earthy carbonates is by calculation ·4508 and the whole amount by experiment ·920, so that it is little more than the quantity required to form with them bicarbonates. It equals nearly 23·7 cubic inches in 100.

II. *Inner Spring.*—The same remarks that have been made with reference to the last will apply here; it contains all of the ingredients there mentioned, but with some little variations in their proportions. Its specific gravity at 60° F. is 1007·71.

1000 grammes of it yield the following ingredients:

Chlorine,	5·13300	Lime,	·19544
Bromine,	·00360	Magnesia,	·16950
Iodine,	·00720	Protoxyd of iron, Alumina,	*trace*
Soda,	4·66480		
Potash,	·02500	Silica,	·05400
Baryta,	·00960	Carbonic acid,	·79200
Strontia,	·00680		

These may be so combined as to give in 1000 parts of the water the following composition:

Chlorid of sodium,	8·42860
" of potassium,	·03820
Bromid of sodium,	·00460
Iodid of sodium,	·00850
Carbonate of soda,	·32606
" of baryta,	·01237
" of strontia,	·00960
" of lime,	·34900
" of magnesia,	·35590
" of iron,	*trace*
Alumina,	
Silica,	·05400
Carbonic acid,	·31250
Water,	990·10067
	1000·00000

The calculated amount of solid matters in 1000 parts of water in 9·58683; experiment gave of residue dried at 300° F., 9·420 in 1000. The small portion of carbonic acid, which is not sufficient to form bicarbonates with the earthy bases, is connected with the presence of carbonate of soda, which, as I have shown in the alkaline waters of Caledonia, forms a double salt with the carbonate of magnesia.* The quantities of adventitious gases as carburetted hydrogen, nitrogen and oxygen, which are present in small portions in these waters, were not determined. The amount of the carbonic acid gas equals 15·78 cubic inches in 100.

For the separation and determination of the baryta and strontia the following method was adopted.† Having evaporated several litres to dryness with an acid, to separate the silica, the residue was dissolved in a small quantity of water, mixed with a little dilute sulphuric acid, and allowed to stand for twenty-four hours. At the end of this time the precipitate then formed was collected on a filter, slightly washed, dried and fused with carbonate of soda. The mass thus obtained was treated with water, and the carbonates after being well washed were dissolved in hydrochloric acid, the solution evaporated to dryness, dissolved in a little water, and mixed with a solution of hydrofluosilicic acid, which on standing gave a granular precipitate of the fluosilicid of barium. The filtrate from this (the washings being rejected as holding in solution a little of the baryta salt), gave with a solution of gypsum after some time, a precipitate of sulphate of stron-

* See this Journal, vol. ix, p. 272.

† See Fresenius Quant. Anal., p. 293, *et seq.*

tia. The nature of this was still farther proved by reconverting it into a chlorid, which dissolved readily in strong alcohol, and gave a solution which burned with a carmine red flame.

St. Léon Spring.—This mineral spring is situated in the valley of the Rivière à la Glaise, about a mile from the church of the Parish of St. Léon. It rises through the clays of the region which there rest upon the Trenton limestone. The water of the spring is clear and strongly saline, and is kept in constant ebullition by the escape of large quantities of carburetted hydrogen gas; the discharge from the spring is very considerable; the temperature of the well was found to be 46° F. on the 12th October, the air being 42°. The specific gravity of the water at 60° is 1011·23; its taste is at the same time decidedly saline and ferruginous, and a qualitative analysis showed the presence of chlorids, bromids and iodids of sodium, potassium, calcium and magnesium; minute quantities of barium and strontium were likewise detected, and carbonates of lime and magnesia as usual, with small portions of alumina, carbonate of iron, and silica.

1000 grammes of the water gave on analysis:

Chlorine,	7·606820	Lime,	·226240
Bromine,	·007956	Magnesia,	·729070
Iodine,	·004230	Protoxyd of iron,	·009000
Soda,	6·094400	Alumina,	·014500
Potash,	·115800	Silica,	·086500
Baryta,	·001360	Carbonic acid,	1·224000
Strontia,	·001270		

These ingredients may be combined to give the following composition for 1000 parts of water:

Chlorid of sodium,	11·496800
" of potassium,	·183200
" of barium,	·001957
" of strontium,	·001960
" of calcium,	·071870
" of magnesium,	·663642
Bromid of magnesium,	·009156
Iodid of magnesium,	·004630
Carbonate of lime,	·349320
" of magnesia,	·938800
" of iron,	·014500
Alumina,	·014500
Silica,	·086500
Carbonic acid,	·577400
Water,	985·585765
	1000·000000

The amount of solid matters in 1000 parts is by calculation 13·836835; the quantity of carbonic acid above that required to form neutral carbonates, is equal to 29·16 cubic inches in 100.

Caxton Spring.—This spring is situated in the township of Caxton, on the Yamachiche River, about five leagues from the village of Yamachiche. The river here flows between banks of clay, which are often sixty to eighty feet high, and exceedingly abrupt. The underlying formations are not exposed in the vicinity, but the position is probably near the dividing line between the Trenton limestone and the Postdam sandstone. The spring rises in the narrow valley that lies at the foot of the hill, and near the river, but a few feet above its ordinary level. The water, which is remarkably transparent, rises with great force, accompanied with volumes of carburetted hydrogen gas, which keep it constantly in violent ebullition. The discharge of water is very considerable, probably six or eight gallons per minute; the temperature of the well was found on the 25th of October, to be 49°, that of the air being 44°. The specific gravity of the water at 60° F. is 1010·36; it is strongly saline to the taste, but from the smaller portion of earthy chlorids, less bitter than that of St. Léon, which it much resembles. Like that, it contains in addition to these and the usual alkaline chlorids, portions of bromids and iodids and a litle carbonate of iron. No salts of barium or strontium were detected.

1000 grammes of the water afforded:

Chlorine,	7·44689	Magnesia,	·65650
Bromine,	·02956	Iron (peroxyd),	·00360
Iodine,	·00355	Alumina,	·00500
Soda,	6·23900	Silica,	·04795
Potash,	·05050	Carbonic acid,	1·12600
Lime,	·14636		

These may be combined to give the following compounds:

Chlorid of sodium,	11·77500
" of potassium,	·08000
" of calcium,	·05030
" of magnesium,	·37435
Bromid of magnesium,	·03420
Iodid of magnesium,	·00390
Carbonate of lime,	·21600
" of magnesia,	1·05930
" of iron,	·00540
Alumina,	·00500
Silica,	·04795
Carbonic acid,	·48200
Water,	985·86660
	1000·00000

The amount of solid matters in 1000 parts is by calculation 13·6514.

The Plantagenet Spring.—I have never visited this spring which is in the township of Plantagenet, not far from the southern bank of the Ottawa, and rises through clays.

The following analysis was performed upon a quantity of water furnished me by the proprietor of the spring in February, 1849.

The water at 60° F. has a specific gravity of 1009·39; its taste is strongly saline, and more bitter than that of the Caxton spring, just described. Analysis shews the presence of the alkaline and earthy chlorids, with portions of bromine and iodine, besides carbonates of lime and magnesia, with traces of carbonate of iron.

1000 grammes of it gave—

	Grammes.		Grammes.
Chlorine, .	6·96020	Lime, . .	·08736
Bromine, .	·00700	Magnesia, .	·52353
Iodine, .	·00480	Iron, protoxyd, .	·00540
Soda, . .	6·18414	Silica, . .	·07000
Potash, .	·05600	Carbonic acid, undetermined.	

These when combined give the following salts for 1000 parts of the water:

Chlorid of sodium, . . .	11·66600
" of potassium, . . .	·10400
" of calcium, . . .	·13640
" of magnesium, . .	·24522
Bromid of magnesium, . .	·00805
Iodid of magnesium, . . .	·00527
Carbonate of lime, . . .	·03300
" of magnesia, . . .	·89043
" of iron, . . .	·00964
Silica, ...	·07000
	13·16801

The similarity between the last three waters is very close both in the nature and quantity of the ingredients which they contain. It will be observed that that of St. Léon contains, like the sources of Varennes, baryta and strontia, but in much smaller portions; while that of Caxton is distinguished by the large amount of earthy carbonates which it contains. These three springs, with the intermittent of Caledonia, constitute a well defined class of saline waters, which are contrasted with the other sources of Caledonia, and those of Varennes. In the first class, all of the soda and portions of the lime and magnesia exist as chlorids, while in the second, the quantity of chlorine is not sufficient for the alkaline bases, and all the lime and magnesia, with a portion of the soda, exist as carbonates. From the presence of the carbonate of soda these waters are alkaline and will possess different

medicinal powers from the others, which contain chlorids of calcium and magnesium; the medicinal action of these two salts, and especially of the chlorid of calcium, is so well marked that their presence ought not to be disregarded in estimating the therapeutic value of a mineral water; the distinction here drawn is therefore one to which I would call the attention of the medical profession, and it may also be found that the presence of such active agents as the salts of baryta and strontia, imparts peculiar medicinal virtues to the waters of Varennes and St. Léon.

Montreal, May, 1849.

ART. XIX.—*Whirlwinds produced by the Burning of a Cane-Brake;* by ALEXANDER FISHER OLMSTED, A.M.—With a Plate.

THE plate accompanying this memoir represents some of the more striking phenomena which attended the burning of a cane-brake near Tuscaloosa, Alabama, on the banks of the Black Warrior river. No engraving or painting can fully represent the magnificence or beauty of the scene, as it owed much to the deep color of the flame, and the vast extent of surface over which it swept, as well as the rapid motion and varied changes of the numerous whirlwinds. The sketch exhibits, however, the forms of many of the whirlwinds that occurred during the progress of the fire, besides other objects that gave interest to the scene.

The cane, as is well known, belongs to the order of Grasses (Gramineæ, family Avenaceæ.)* It grows to a height of thirty-five or forty feet,† although but an inch or two in diameter at base, and has a round, hollow stem, with knots every twelve or fourteen inches. At the top there is a head of foliage, brush-like in appearance, made up of long linear leaves. The canes are met with on the banks of all the rivers in the extreme Southern and South-western States, particularly in the States of Alabama, Mississippi, Louisiana, and Texas. The rapidity of their growth is wonderful. It is reported that young plants sometimes increase ten inches in length in a single night, and a large tract of land in a favorable situation will become covered with full grown canes in an incredibly short period. They form dense thickets, the stems often standing but an inch or two apart, although rising thirty-five or forty feet. They thus constitute a barrier impenetrable by man and large animals, and consequently become a refuge for all kinds of small animals. Through the thickets there are occasional passages due to streamlets or some variation of soil. There are occasional large trees here and there in a cane-

* *Arundinaria macrosperma* of Michaux, *Ludolfia macrosperma* of Wildenow. There is a smaller kind of cane that grows in Georgia and the neighboring states, and forms cane-brakes equally impassable.

† The sugar-cane usually grows from eight to ten feet.

brake, which probably started before the cane covered the land; but almost all other vegetation is excluded. In clearing such land only a few simple tools are employed,—as a carpenter's adze, or an axe, or a heavy kind of hoe called a "cane hoe,"—and a single blow is sufficient to divide the stalk. The laborer grasps the cane with one hand, and, as he cuts it, throws it behind him and passes on. In this way, an acre of land is soon cleared. To prepare it for the plough it is only necessary to fire the cane; as the roots are, for the most part, near the surface, they are consumed at the same time, and the land is then ready for immediate tillage. From the ease with which it is cleared and from the fertility of the soil, (which may be accurately determined by the size of the canes,) cane land is preferred above all others in the region.

The canes lie for a month or six weeks to dry, and then are gathered into heaps and set on fire in several places at once. As soon as the burning begins, the air that is confined in the hollow jointed stalks, and also the watery vapor, expand and burst the canes asunder with a loud report. These explosions occurring from a vast number of canes at the same time produce a continued roar like the discharge of musketry from an immense army, while the flames roll on with great rapidity. No other sound besides this continued roaring is heard in the progress of the fire. This scene therefore differs widely from fires of brush and timber, such as those described in the thirty-sixth volume of the Journal of Science, which produced whirlwinds accompanied by thunder.

The flame advancing over the dry cane presents tints of an intensity and richness incomparably finer than those produced by the combustion of any other kind of wood. No color or combination of colors possessed by the painter can equal it, and it is even unsurpassed by the red of the prismatic spectrum. The tint is best compared to the deepest red of the spectrum. The smoke also was hardly less magnificent as it rolled upwards from the low ground where the fire was raging far above the elevation on which we stood. Its dense, black masses were darker than the darkest thunder cloud. Instead of the light colors of ordinary smoke, a deep dull black characterized the whirlwinds, and the dense volumes of smoke which enveloped the whole scene. On the edge of the fire, the smoke was equally black, but somewhat less dense. This was true also of some of the whirlwinds, particularly those of the form represented by No. 2, while most of the other forms were revolving masses of dense black smoke.

The cane-brake on which this burning took place covered a space of twenty-five acres. It was set on fire at the part most distant from us, and the tract of land being somewhat curved and irregular, the fire was at first hid from our view. The smoke, however, was visible from the commencement, and the roar of a thousand discharges announced its rapid progress. Soon the flame and smoke issued from behind the wood by which it had

been sometime concealed. The heat became intense where we stood, although at a distance of more than two hundred yards from the fire.

Whirlwinds of a great variety of forms began now to be observed in the hottest part of the fire, gradually increasing in size, in number, and in the space over which they prevailed. In this respect they differed from the whirlwinds already alluded to as described in the Journal of Science, where the flame and smoke united in a single column and the energy of the fire was concentrated towards that column.

These whirlwinds at first were on a comparatively small scale, their height not exceeding thirty-five or forty feet. To these succeeded others on a larger scale, until they reached the height of more than two hundred feet, and the flame and smoke which formed their columns were perfectly distinct from the general mass which rose from the fire. Even after the fire had to a great extent gone down, many whirlwinds were formed on the ashes, and continued to form until we left. During the latter part of the time, however, the whirlwinds were, chiefly, those marked 2 and 3 in the plate.

The kinds of whirlwinds that occurred during the progress of the fire may be arranged under four heads.

1. The most common form was that which was stationary over a part of the fire that was hotter than the neighboring portions. This is represented in No. 4. Its base rests on a pile of burning cane, and the air at this part flows in from all sides towards the center. The smoke and flame, however, soon assume a rotary motion in the column above, and the whole expands into the hour-glass form or funnel shape of the common whirlwinds often seen on a small scale.

2. The second variety (No. 2,) has a progressive motion. Its shape almost indicates the mode in which it was formed. These generally occur over the ashes, being produced in the air above, and were therefore like the upper part of No. 4, and like the whirlwinds very often produced by the meeting of currents of air. Some of these emerged from the flames and became invisible. One, however, passed near enough to us to be noticed by its rustling sound and the leaves which it carried up. This was about fifteen or twenty feet high. It moved slowly by us as we stood about three hundred yards from the fire, (having retreated somewhat from our former position.) Towards the latter part of the fire some very large whirlwinds of this form were seen spinning, like tops, over the ashes, from one part of the fire to the other, marking their paths by blowing the ashes and cinders aside and carrying up only the small amount of ashes which was directly under the points of their cones.

3. A very interesting phenomenon occurred in some of the whirlwinds which is represented in No. 5. This whirlwind is

formed on a pile of burning cane. The flame rolls up into a column where it is extinguished and is succeeded by a dark interval of smoke. Above, and towards the top, the flame breaks out anew. The dark interval is not uniform, but sometimes diminishes almost to a line, and then expands upwards till it covers and extinguishes all the upper portions of the flame. This phenomenon might have been owing to a difference of velocity in the different parts of the whirlwind. The greatest velocity was in the dark interval, and the flame was extinguished in this part on the same principle that a gas jet burns high above, but not on its orifice when a powerful stream of gas is supplied. The gas in this case, by its concentrated form and rapid motion, is not brought into contact with the oxygen of the air sufficiently until it reaches a certain height above the orifice. In the same way the combustible gases of the whirlwind, by their rapid motion and concentrated form in the middle portion of the whirl, do not take fire until they expand above and are mingled more fully with the atmospheric air. The velocity of the whirlwinds would, doubtless, vary continually more or less, and this would account for the continued variation in the size of the dark interval, sometimes diminishing to a line or disappearing when the whirlwind moved comparatively slow, and then expanding with the increased velocity of rotation until all the flame of the upper part was extinguished, and a cone of smoke rested on the base of flame.

4. The whirlwinds of the 4th kind (Nos. 3, 3,) were remarkable for being entirely destitute of the funnel form, for their small diameter, and for their immense height, which was often several hundred feet as indicated by the smoke, and was probably prolonged into the transparent air above. It is a fact of great interest that even in these tall cylindrical whirlwinds, the rotary motion was perfectly obvious throughout their entire length, rolling the black smoke in wreaths like carded wool to the top of the visible column, and probably beyond, as we may infer from their rapid motion.* Towards the top, these whirlwinds were sometimes bent by the wind. This change of direction was more sudden or abrupt than is represented in the plate, and the whirl-

* Some remarks by Mr. Redfield on the whirlwinds already alluded to are peculiarly applicable to this form. "The ascending power of the vertical column or whirlwind is, in these cases, strongly exhibited. We observe that the heated air from large fires, or even from the most powerful furnaces, ejected in a column at the heat of melted iron, will ascend only to a comparatively short distance from the earth; the ascending force being lost in the counter movements and convolutions with the adjacent colder air and the combined product soon spreads off in a horizontal direction. But the spire of a columnar vortex exhibits a penetrating and ascending power which far exceeds both in intensity and extent of action, any other ascending movement that we witness in the atmosphere. The effect appears to be owing to the spiral motion of the column, which presses onward in the direction of its axis, until it reaches a limit of elevation which is yet unknown. Even the *ring vortex*, which is sometimes seen to form at the muzzles of cannon or the ejection pipes of high pressure steam engines, appears to possess the qualities of a projectile, notwithstanding its unfavorable form."

wind was continued notwithstanding the change in its direction. Some were bent into a direction nearly or quite horizontal still revolving rapidly, others were less inclined, and others were cut off on a level with the general mass of smoke or prolonged into the transparent air above.

In connection with the whirlwinds several other facts of interest may be mentioned which occurred during the burning of the cane.

1. The direction of the wind was changed. Being at first from the northeast, it continued in that direction in the upper part of the atmosphere, as was evident from the way in which the columns of smoke were bent. But shortly after the commencement of the burning, the air beneath blew in all directions towards the center of the fire. The columns of smoke rising nearly straight for more than two hundred yards, and being then quite suddenly bent, served to indicate accurately where the general northeast wind prevailed over the currents that surrounded the fire. The influence of the fire may therefore be considered as having extended more than two hundred yards* in height, and over an area of more than three hundred yards around, for at this distance the air blew strongly towards the fire.

2. The entire influence of the fire appeared to be expended on the air in its vicinity, and to produce no effect on the general state of the atmosphere, either at the time or subsequently. This fact is the more important as storms in the region where this fire occurred, particularly thunder storms, are much more frequent and violent than in the Northern States.

3. The whole mass of the air, after entering the area above the fire, exhibited a tendency to rotary motion, being full of eddies and whirlwinds.

4. These whirlwinds revolved on their axes from right to left, and from left to right, without any prevailing tendency to one direction more than to the other. Frequently the same whirlwind would change the direction in which it revolved and would return to its first course. In a few instances this was repeated several times. In no instance, however, was this repeated change of rotation observed in the whirlwinds of the form represented in No. 2, and from this it was evident that this change was owing to a change in the form of the base, as the fire burned down the pile of cane on which the whirlwind was formed. The nicely balanced columns of air ascending in the whirlwind would commence rotation in either direction by a slight inequality in the fire on one side of the base, and would change their rotation when this inequality was from some cause shifted to another part.

* Probably more than three hundred yards—there was no object with which to compare these columns except a few scattering trees in the fire.

5. As the fire spread rapidly from different points, it was at length circular in outline, or approached this form. It was not until the heated air was rising from this circle that the whirlwinds became frequent in number or of great size. The same phenomena are shown on a small scale in the common process of putting tire on wheels, where the whole body of air and smoke above the fire appears full of eddies and whirls. If these fires are made in a yard surrounded by high buildings, the effect is greatly increased. In some situations of this kind, whirlwinds of quite regular forms and fifteen or twenty feet high, are sometimes seen. But owing to the dry wood of which these fires are usually formed, and the very small amount of light colored smoke which is produced by this wood, it is generally difficult to determine the exact forms which the whirls assume; yet at different times all the kinds described in this article have been observed.

These facts have a bearing upon the method which has been proposed of producing rain by circular fires. It has been maintained that if a circular fire were created the air would be made to ascend in a single column, a cloud would be formed in the upper part of this column or at the top, and this cloud being thus formed, would subsequently produce rain. The whole theory, therefore, depends upon the first supposition that the air would ascend in a single column; but from the phenomena which attended the burning of the cane-brake, I have been led to the conclusion, that, unless the mass of combustibles were very great, and the fire very intense, no single column of rarefied air, in the majority of cases, would be formed, and, consequently, the phenomena dependent (as it is maintained) upon this supposition would not take place. The great heat produced by the burning of the canes appears, from the fact that we were obliged to move from a station within two hundred yards of the fire to one distant about three hundred yards, and even at this distance the heat of the fire was so strong that most of the company present were at a distance still greater. In all the cases mentioned in the Journal of Science, the mass of combustible matter was very great, and, in one case at least, was piled up towards the center.

6. The location of the cane-brake was very favorable to the formation of whirlwinds, being a river bank, to a great extent surrounded by woods and higher land. It corresponded in some degree to the fires for putting tire on wheels when these are kindled in an inclosure partly surrounded by buildings. I have been informed that the whole air of a large space thus inclosed is sometimes affected by these fires and put in motion in a direction opposite to the general course of the wind. A rotary motion sometimes pervades the air of these places.

7. In the midst of the fire the foliage of the trees (No. 6,) became gradually dried and parched, and finally caught on fire, burning almost with a flash like powder, and adding greatly to the

splendor of the scene. By contrast with the deep-red flame of the canes, the flame of these trees appeared of a very light-red color, and the white smoke of the burning trunks was also in lively contrast with the heavy rolling masses of black smoke which surrounded the fire.

8. The charred leaves of the cane being thin and light were driven off in considerable quantities. They were frequently carried up and were sometimes found at a distance from the place of the fire. Compared, however, with the extent of the fire, and the immense amount of matter consumed, very little was carried off in this manner. The combustion was complete as well as rapid, owing to the dryness of the material, the thinness of the stems and stalks of which it consisted, and the speedy explosion of the hollow joints on the first approach of the fire. Moreover neither the lighter nor heavier parts could rise unconsumed to a great height through the hot air and flame which were above the fire.

These are some of the principal facts which attended this burning. It is a scene of not very common occurrence even at the South, and when it does take place, a few circumstances may entirely change the effect. If, for example, the cane is not sufficiently dry, or if it has been covered with sediment from an overflow of the river on the banks of which it grows, the effect will be changed either in the color of the flame, the rapidity of the fire, or the production of whirlwinds. We were, however, assured that the phenomena we witnessed were such as usually attended the burning of a cane-brake when whirlwinds are produced, though sometimes they occur on a larger scale and in a more striking manner.

ART. XX.—*Description of a new Graptolite found in the lower Silurian Rocks near the Falls of St. Croix River;* by H. A. PROUT, M.D.

THE remains of Graptolites are generally found in so imperfect a state of preservation that their exact place in the scale of animal existence has been a subject of controversy. Some authors have been disposed to refer them to the vegetable world, while others have compared them to some of the lower forms of animal life. Among those who have established a place for them in the *zoological* series we find again some diversity of opinion. Wahlenberg and Schlotheim refer them to the Orthocerata; Nilsson to the Fixed Corticate zoophytes (Gorgonidæ or Antipathidæ); Dr. Beck, of Copenhagen, Murchison, Mantell, Hall and others, to the Pennatulidæ, while other eminent writers have been disposed to place them in the tribe of Sertularia, in the family of Tubularidæ.

When we compare the analogies in the organization of the Gorgonidæ, the Virgulariæ, and the Sertulariæ, this difference of opinion, in regard to the true place of the Graptolites, may, in some measure, be explained. The Gorgonidæ and Pennatulidæ have a long semi-calcareous or horny axis enveloped in a fleshy or coriaceous covering; the Polypi are inserted in, or rather constitute, this cortical envelope, which forms a common bond of association, and have no articulation with the central axis. In the Sertularia on the contrary, the corneous, or hard portion of the polyparium, is external—the axis is traversed by a fluid or gelatinous substance —the cup-like cells or denticles pertaining to the polypi are tubular and have a connection with the material which occupies the interior.

In the relative changes which would materially take place after the death of these Polypi, it suggests itself to us that the more corneous or calcareous portion would be least liable to decay, and consequently more subject to fossilization, while the gelatinous or fleshy part would be subject to rapid decomposition.

It is well known that a destruction of the cortical covering as well as the horny or calcareous axis very frequently occurs, and the imperfect impressions which they leave, impart some uncertainty to the distinctions which have been founded upon them. Moreover it is obvious that according to the position of the Polypi on the polyparium at the time of extinction, or the relative position of the setæ to the surface of the rock, when subsequently brought to light, some variation in the appearance of the same species may give rise to unnecessary distinctions in an attempt at a regular classification of these bodies.

Dr. Beck gives to Graptolites the following generic characters:

"Polyparium—indivisum, elongatum, sublineare, acuminatum, obtusiusculum, statu fossili compressissimum serratum."

"Polypi alternantes cum tubulo communi centrali communicantes in fossili statu sæpissime secati rarius bifarii oblongi acuminati."*

It is obvious that the clause, "cum tubulo communi centrali communicantes," implies that the polyparium and the denticles are both tubular. The axis, in most of those which we have seen described, is represented as being capillary while it is not stated whether they are solid or tubular, or whether the setæ or dissepiments are tubular or clasping. With due deference to the opinion of Dr. Beck and others, I am inclined to believe that the species which I shall presently describe, and perhaps all others characterized by a hollow central tube and tubular cells for the reception of the Polypi, more probably owe their origin to the tribe of Sertularia than to Virgularia—for we have seen

* Murchison's Silurian System, p. 695.

that the tubes of the Polypi, in the Virgulariæ and Gorgonidæ have no regular connection with the central axis except through the medium of a fleshy or coriaceous envelop, and in the fossil state it is difficult to account for a tubular appearance or a regular connection between the receptacles of the Polypi, (which in Virgularia are mere setæ,) and a common central tube, unless we suppose the entire destruction of the central or semicalcareous stem, while the softer and more destructible fleshy envelop remained in a perfect state of preservation. We should much sooner anticipate a destruction of the cortical substance than the harder and more durable axial support. We know that this relative change does take place in the living genus of Antipathes, while in the Gorgoniæ, the central axis and the cortical portion are both preserved, but only in virtue of the calcareous matter which enters into the constitution of the cortex. The axis being preserved in both these genera, while the cortical substance in one is subject to decay, renders it probable, I may say certain, that the central stem is in general the most indestructible portion of the zoophyte.

We have been led to this course of reflection by the absence, in the specimen which we are about to describe, of any central axis or stem, and the general tubular structure of the polyparium.

In it, the cup-like denticles are inserted into a common connecting tube, are unilateral and vaginated on their external sides, the side of one cup supporting the next one above it in the series, in which last feature it much resembles some of the living forms of Sertularidæ.

From the appearance manifested in this specimen, we are inclined to infer that Sertularidæ existed at the same time with Pennatulidæ in the ancient seas, and that on a more critical examination of the subject, some of the differences of opinion upon the origin of the Graptolites may be found more seeming than real.

The species of Graptolites which we have discovered differ materially from those figured by Murchison or Hall. We have not seen the monograph of Dr. Beck, but presume if he had described the species, it would have been frequently referred to, not less on account of its structure than the elegance of its form. We shall therefore describe it as a new species, giving it at the same time the name of Graptolithus Hallianus, after Professor Hall, whose labors in the field of American Palæontology so justly entitle him to this honor.

Graptolithus Hallianus.

Polyparium hollow, well defined, branching in a graceful raceme, much branched, branches mostly on one side, never opposite, with unilateral cells, each supporting the next one above it, no solid axis or stype.

Polyp-cells.—To the naked eye the cells appear closely serried, not appressed, transversely serrated; but under a magnifying glass, they appear vaginated, hollow, having a connection with a common central tube, conical with point of cone downwards, sometimes having a faint appearance of a mucronate point on the outer lip, and two longitudinal lateral ribs, extending from the base to the terminal border.

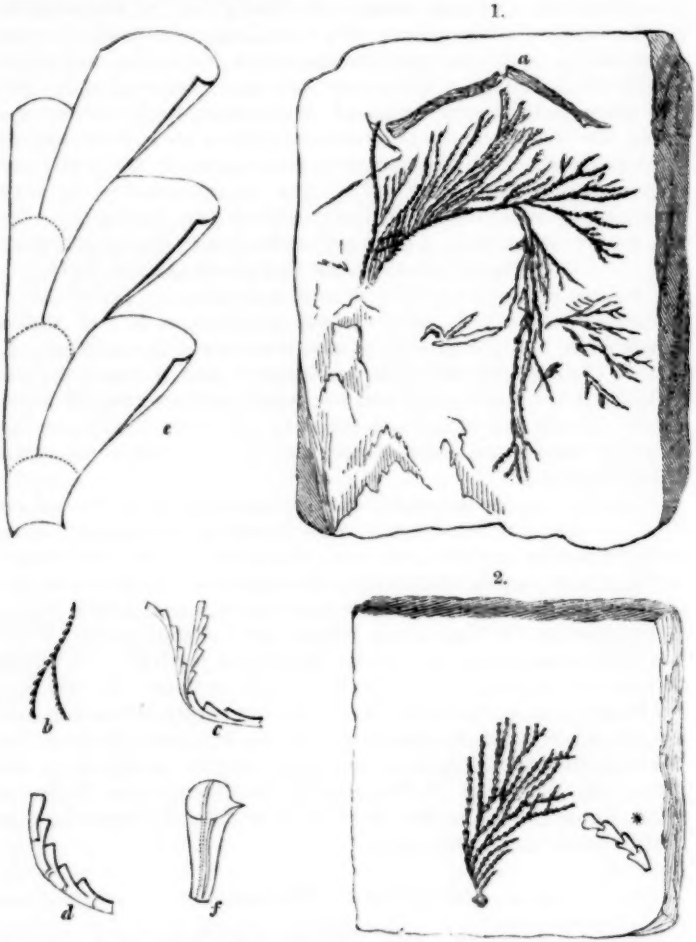


Fig. 1. Graptolithus Hallianus, natural size. Fig. 2. Same, showing the structure more definitely.—*a* (fig. 1), large Graptolite of another species; *b*, a branch nearly natural size; *c*, *d*, magnified; *e*, diagram of supposed structure; *f*, diagram of cell.

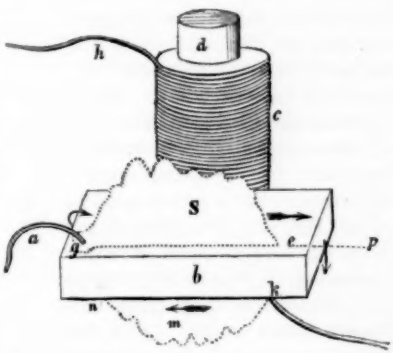
This species, which has some general resemblance to the Graptolithus gracilis of Professor Hall, differs in being much more branched, more closely serrated, with serratures not appressed, hollow, conical, and connected with a central tube, instead of a slender stype.

The larger Graptolite marked *a* on figure 1, seems to have belonged to another species, its marking is somewhat indistinct under a high magnifying power, but it seems to be covered with close set setæ much appressed and verticillate in their general arrangement. To the naked eye it appears to be longitudinally wrinkled.

Position and locality—Osceola Mills, near the falls of St. Croix River, in a thin seam of calcareo-aluminous shale, fifty feet above the water level.

ART. XXI.—*On the direction of the Spark from Secondary Currents under the influence of Helices or Magnets;* by Prof. CHAS. G. PAGE, M.D., Washington, D. C.

IN the course of my experiments, recently communicated, in which secondary sparks were obtained from two to six inches in length, the spark seemed to have *direction*, and in the operation of the electro-magnetic engine this peculiar property of the spark was occasionally annoying from the fact of its running along and oxydating metallic surfaces which were intended to be kept clean and bright. On investigating this matter, I found the spark to be subject to the same tangential or rotative action as the conductor itself.



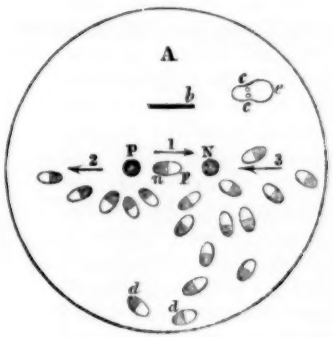
Let *a*, represent one pole of the battery, *b*, a block of copper in connection with one termination of the helix *c*, *h*, the other pole of the battery in connection with the other end of the helix. *d*, the magnet within the helix, and *g* the first point of contact with the copper block. When the maximum of current is reached which is about a second after contact is made, and the current then broken, a dense spark or flame, S, about one inch in height is directed along the surface of the block from *g* to *e*. The lower line of the spark or that portion on the surface

of the block is broken up into brilliant points and dashes. When the wire is placed underneath the block, as at *k*, the spark is impelled in a contrary direction, or from *k* to *n*. If the current is broken at *e*, and the wire drawn suddenly over the end of the block in the direction of *e p*, the spark follows the same direction running off in a brilliant line of light several inches in length. From the direction of the spark above, below and on the ends of the block as shown by the arrows, it appears that the spark or secondary current obeys the same rotative action as does the conductor itself. In arranging the breaks or cut-off in the electro-magnetic engine, it is obvious that this discovery has an important practical bearing, and it will also be important to attend to this point in experiments made with a view to obtain the greatest length of secondary spark. If the position of the block be varied in the experiment so as to place it above the coil, the direction of the spark will be reversed. The influence of the coil in directing the spark was perceived even when the current was broken three feet from the coil.

ART. XXII.—*On the Conduction and Distribution of the Galvanic Current in Liquids;* by Prof. CHAS. G. PAGE, M.D., Washington, D. C.

When the poles of a galvanic battery are immersed in a conducting liquid the current does not wholly pass in the shortest distance between the poles but is distributed in all directions outward and to a considerable extent radially.

Thus if a large plate or dish A, is filled with acidulated water and we immerse in it the poles P N of a galvanic battery the current will be found to have the direction generally of the arrows, 1, 2, 3, at those points. On communicating this fact several years since to Prof. Henry, he informed me that he had noticed it some years before, but that his mode of illustration was quite different from mine. The design therefore of this communication is only to describe my own method and results, some of which are quite novel. The little oval figures, *d*, *d*, represent globules of mercury in the acidulated water and their condition



while the current is passing. The mercury for this purpose must be *very pure*. Before the current is established, the globule of mercury has its usual spherical form, but as soon as the current flows, the globule immediately elongates and moves rapidly towards the negative pole of the battery. This movement takes place when the globule of mercury is at a very considerable distance from the wire, and with very pure mercury it will move up an inclined side of the dish. This curious movement or propulsion appears to be caused by the development of gas about the negative end of the globule. One half of the globule becomes clouded and the other half remains clear and bright. The clouded half is turned towards the positive pole. In the figure, *d*, *d*, exhibit the appearance of the globules, and P, N, the positive and negative poles of the battery, which in this case are platinum wires. Bits of platinum wire laid in the dish as at *b*, give off gases at their extremities, but a peculiar advantage comes from using the globule of mercury, as it elongates and turns itself at once in the direction of the current passing through it. In the figure, quite a number of these globules are represented nearly in the positions assumed in the experiment. When the negative pole is brought directly over a globule of some size, say from $\frac{1}{4}$ to $\frac{1}{2}$ inch diameter, it is thrown into a violent agitation and has a kind of rotary movement from its rapid elongation in every possible direction. Occasionally the globule takes the form as seen at *e*, the larger portion being towards the negative pole, and in this case both ends of the globule are bright, the clouded portion being at *c*, *c*, and here there appeared two little vortices, each having a most rapid whirl.

If now some impure mercury containing zinc be introduced in place of the pure, a singular and reverse condition follows. The end of the globule which was before clouded, becomes clear, and *vice versa*. The movements are less active from greater friction, and also from what appears to be a constrained condition of the polar properties of the globule. The propulsion also of the globule is in the reverse direction, and from the negative to the positive pole, and sluggish in comparison with the motion of a globule of pure mercury. This contrary movement and state of the globule is not easily explained. It occurred to me that the zinc contained in the mercury was detained on the oxygen or positive end of the globule and the mercury as it were filtered out from it. If this supposition be correct, the hydrogen developed at the positive end of the globule by local action, might account for the contrary propulsion and reversal of the whole aspect of the globule. This solution does not however seem to be wholly satisfactory.

Washington, D. C., Dec. 4, 1850.

ART. XXIII.—*Two Problems by Bāpu Deva Shāstri*, Native Professor of Mathematics in the Benares College.* (Communicated for this Journal by Mr. B. H. HALL, and transmitted to this country by Prof. FITZ-EDWARD HALL, of the College of Benares.)

PROBLEM I.

GIVEN an arc and its chord to find the sagitta.

Let A = the given arc, and B = the given chord.

Also let a be an arc similar to A having a rad = 1.

Then $$\frac{A}{B}=\frac{a}{\text{ch.}a}=\frac{a}{a-\frac{a^3}{2^3.3}+\frac{a^5}{2^5.3.4.5}-\text{ \&c.}}\ (\text{Dif. Cal.})=m$$

$$\therefore m=\frac{1}{1-\frac{a^2}{2^3.3}+\frac{a^4}{2^5.3.4.5}-\text{ \&c.}}=\frac{1}{1-Aa^2+Ba^4-Ca^6+\text{\&c.}}$$

$$\therefore \frac{1}{m}=1-Aa^2+Ba^4-Ca^6+\text{\&c.}$$

$$\therefore \text{By trans. } Aa^2-Ba^4+Ca^6-Da^8+\text{\&c.}=1-\frac{1}{m}=\frac{m-1}{m}.$$

Let $$n=\frac{m-1}{m}=\frac{\frac{A}{B}-1}{\frac{A}{B}}=\frac{A-B}{A}$$

Then $$n=Aa^2-Ba^4+Ca^6-Da^8+\text{\&c.}$$

$\therefore$ By reversion of the series,

$$a^2=\frac{n}{A}+\frac{Bn^2}{A^3}+\frac{(2B^2-AC)n^3}{A^5}+\frac{(5B^3-5ABC+A^2D)n^4}{A^7}+\text{\&c.}$$

Again, sagitta of $$a=\frac{a^3}{2^3}-\frac{a^4}{2^5.3.4}+\frac{a^6}{2^7.3.4.5.6}-\text{\&c.}\ (\text{Dif. Cal.})$$

$$=3Aa^2-5Ba^4+7Ca^6-\text{\&c.}\quad (\text{By subtrn.})$$

$$=3n+\frac{3Bn^2}{A^2}+\frac{3(2B^2-AC)n^3}{A^4}+\frac{3(5B^3-5ABC+A^2D)n^4}{A^6}+\text{\&c.}$$

$$-\frac{5Bn^2}{A^2}-\frac{10B^2n^3}{A^4}-\frac{(20B^3-20ABC)n^4}{A^6}-\text{\&c.}$$

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* The principal interest connected with these demonstrations arises from their being an example of the mathematical science of India.—EDS.

$$-\frac{5B^3n^4}{A^6}+\&c. \quad +\frac{7ACn^3}{A^4}+\frac{21ABCn^4}{A^6}+\&c.$$

$$-\frac{9A^2Dn^4}{A^6}+\&c.$$

$$=3n-\frac{2Bn^2}{A^2}+\frac{4(AC-B^2)n^3}{A^4}-\frac{2(5B^3-13ABC+3A^2D)n^4}{A^6}+\&c.$$

But $a^2=\frac{n}{A}+\frac{Bn^2}{A^3}+\frac{(2B^2-AC)n^3}{A^5}+\frac{(5B^3-5ABC+A^2D)n^4}{A^7}+\cdots$

$A=\frac{1}{2^3.2}$, $B=\frac{1}{2^5.2.4.5}$, $C=\frac{1}{2^7.3.4.5.6.7}$, $D=\frac{1}{2^9.3.4.5.6.7.8.9}$

$\therefore$ by subtrn., $a^2=24n+\frac{36}{5}n^2+\frac{387}{175}n^3+\frac{312}{175}n^4+\&c.$ (1)

$$=6n(4+\frac{6}{5}n+\frac{129}{350}n^2+\frac{52}{175}n^3+\&c.)$$

And sagitta of $a=3n-\frac{3}{5}n^2-\frac{33}{175}n^3+\frac{3}{70}n^4+\&c.$

And by extr. the sq. root of (1) $a=\sqrt{6n}(2+\frac{3}{10}n+\frac{39}{560}n^2+\frac{143}{2240}n^3+\&c.)$

Now a : sagitta of a :: A : sagitta of A

$$\therefore \text{sagitta of A}=\frac{\text{A}\times\text{sagitta of } a}{a}$$

$$=\frac{A}{\sqrt{6n}}\cdot\frac{3n-\frac{3}{5}n^2-\frac{33}{175}n^3+\frac{3}{70}n^4+\&c.}{2+\frac{3}{10}n+\frac{39}{560}n^2+\frac{143}{2240}n^3+\&c.}$$

$$=A\sqrt{6n}.\frac{\frac{1}{2}-\frac{1}{10}n-\frac{11}{350}n^2+\frac{1}{140}n^3+\&c.}{2+\frac{3}{10}n+\frac{39}{560}n^2+\frac{147}{2240}n^3+\&c.}$$

$$=A\sqrt{6n}\left(\frac{1}{4}-\frac{7}{80}n-\frac{253}{22400}n^2+\frac{149}{448000}n^3+\&c.\right)$$

Example. Given the arc $=9$ and the chord $=8$ } to find the sagitta.

Here $A=9$, $B=8$, and $\therefore n=\frac{1}{9}$

Then the sagitta of $A = A\sqrt{6n}\left(\frac{1}{4} - \frac{7}{80}n - \frac{253}{22400}n^2 + \frac{149}{448000}n^3 + \&c.\right)$

$$= 9\sqrt{6 \cdot \frac{1}{9}} \cdot \left(\frac{1}{4} - \&c.\right)$$

$$= 3\sqrt{6}(.24014)$$

$$= 3 \times 2{\cdot}44949 \times {\cdot}24014$$

$$= 1{\cdot}76466 = 1\frac{3}{4} \text{ nearly.}$$

Problem II.*

Given an arc and its chord to find the sagitta.

Rule.—Multiply the given arc by 100,000 and divide the product by the given chord. Diminish the quotient by the nearest tabular quotient in col. 4 and set down the difference. (*a*)

2. Take the said tabular quotient from the one immediately following it, and similarly find the difference of the corresponding tabular chords and sagitta.

3. Multiply the difference (*a*) by the 2nd and 3d of the three last mentioned differences respectively, and divide the products by the first.

4. Increase these quotients respectively, by the tabular chords and sagitta which have been made subtrahends (§ 2.) Multiply the 2d sum by the given chord and divide the product by the 1st, and the result is the value of the sagitta required.

Similarly the chord may be determined when the arc and the sagitta are given. But in making the calculation the chord is to be considered as the sagitta and vice versa.

Also when the tabular difference (§ 2.) is not less than the one immediately following it, it must be subtracted from that immediately preceding it. And in (§ 4.) the quotients are to be subtracted from the minuends.

Dem.—The ratios of similar arcs and their chords being equal, 100,000 times† the ratios of arcs and their chords are easily found and set down in tables. Opposite to these the chords of similar arcs and their sagittas are also given. Hence the value of any sagitta may be easily determined by simple proportion.

A similar demonstration will apply to the rule for determining the chord, when the arc and its sagitta are given.

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* This Problem is printed in the Benares Recorder.

† The ratios have been multiplied by 100,000 in order to avoid fractions.

Chords.	Sagitta.	Arcs.	Chord.	Sagitta.
10467	137	10472	100046	7643796
20906	548	20944	100183	3821898
31287	1231	31416	100413	2552072
41582	2185	41888	100735	1964066
51764	3407	52360	101152	1536836
61803	4894	62832	101664	1285901
71674	6642	73304	102275	1103643
81347	8645	83776	102986	969069
90798	10899	94248	103800	864739
100000	13397	104720	104720	783160
108928	16133	115192	105753	713395
117557	19098	125664	106890	657996
125864	22285	136136	108174	615239
133826	25646	146608	109551	571660
141721	29289	157080	110838	536311
148629	33087	167552	112733	506899
155429	37068	178024	114537	480263
161803	41221	188496	116498	457259
167734	45536	198968	118622	436990
173205	50000	209440	120920	418880
178201	54601	219912	123407	402762
182709	59326	230384	126094	388335
186716	64163	240856	129103	375381
190211	69098	251328	132132	363727
193185	74118	261800	135518	353220
195629	79209	272272	139177	343738
197538	84357	282744	143134	335175
198904	89547	293216	147416	327555
199726	94766	303688	152052	320461
200000	100000	314160	157080	314160
199726	105234	324632	162539	308487
198904	110453	335104	168476	303391
197538	115643	345576	174942	298830
195629	120791	356048	182002	294690
193185	125782	366520	189725	291393
190211	130902	376992	198197	287996
186716	135837	387464	207515	285241
182709	140647	397936	217798	282879
178201	145399	408408	229184	280889
173205	150000	418880	241840	279253
167734	154464	429352	256569	277833
161803	158779	439824	271827	277004
155429	162932	450296	289711	276371
148629	166913	460768	310012	276053
141721	170711	471240	325456	276045
133826	174354	481712	359954	276284
125864	177715	492184	391044	276952
117557	180902	502656	427585	277861
108928	183867	513128	471073	279007
100000	186603	523600	523600	280596
90798	189101	534072	599730	282427
81347	191355	544544	669406	284572
71674	193358	555016	774366	287039
61803	195106	565488	914979	289836
51764	196593	575960	1112669	292971
41582	197815	586432	1410291	296452
31287	198769	596904	1907840	300300
20906	199452	607386	2905318	304522
10467	199863	617848	5902707	309136
0	200000	628320	ad infinitum	314160

These tables may be carried to any degree of accuracy by increasing the subdivision of the arcs.

Ex. The arc $= 9$, chord $= 8$ } to find the sagitta.

Here $\dfrac{100{,}000 \times 4}{8} = 112500$

And $112733 - 110383 = 1895$

Also $148629 - 141721 = 6908$

and $33087 - 29289 = 3798$

Again $\dfrac{1662 \times 6908}{1895} = 6059$

and $\dfrac{1662 \times 3798}{1895} = 3331$

Then $6059 + 141721 = 147780$

and $3331 + 29289 = 32620$

Now $\dfrac{32620 + 8}{147780} = 1\dfrac{5659}{7381} = 1\dfrac{3}{4}$ nearly

$\therefore$ the value of the sagitta required.

The minimum ratio of the arc and its sagitta may thus be determined by the differential calculus.

Let arc $= 2x$

then $\dfrac{2x}{\text{sagitta of } 2}$ or $\dfrac{x}{\text{vers } x}$ will be the minimum ratio required

$$\therefore u = \frac{x}{\text{vers } x} \text{ and } \frac{du}{dx} = \frac{\text{vers } x - x . \sin x}{\text{vers}^2 x} = 0$$

$$\therefore x = \frac{\text{vers } x}{\sin x} \text{ which gives } x = 133^\circ\ 33'\ 48''\ 29''' = 2.3311222$$

when the rad $= 1$ and sagitta $= 1.6891576$.

$\therefore$ The minimum ratio of the arc and its sagitta is

$$\frac{2x}{\text{sagitta } 2x} = \frac{4.6622444}{1.6891576} = 2.7601004$$

Now $2.7601004 \times 100{,}000 = 276010{\cdot}04$

And it may be proved by reference to the table that this, which the differential calculus gives as a minimum, is the minimum, for it will be seen to be less than any other number in the column.

ART. XXIV.—*On the Vents of Hot Vapor in Tuscany, and their relations to Ancient Lines of Fracture and Eruption;* by Sir RODERICK IMPEY MURCHISON, G.C.St.S., F.R.S., G.S., L.S.*

Introduction.—IN surveying the principal localities of those remarkable vents of hot vapor in the Tuscan Maremma, called "Lagoni," "Fumacchi," "Fumarole," "Soffioni," "Mofetti," and even "Volcani,"† I perceived that their issue took place upon ancient parallel lines of fracture, along which serpentinous and other eruptive rocks had been emitted. As I am not aware that this coincidence in lines of eruption, acted upon at epochs so remote from each other, has been previously adverted to in any geological account of Tuscany, I will first call attention to the phenomenon. I shall next take this opportunity of expressing my opinion respecting the origin of the "gabbro rosso" of the Tuscans, a rock intimately associated with serpentine; and, after a brief allusion to recent earthquake shocks along the same lines, the memoir will be terminated by glancing at the simultaneous production of great divergent elevations in Italy and in the Alps, after the deposit of the nummulitic eocene formation.

Hot vapor vents.—If the intensely hot vapor gusts which have issued for centuries from cavities in the rocks of the Tuscan Maremma had been as well known to Dante, as they were to Targioni Tozzetti their graphic describer in the last century, the great poet would surely have selected them as a finer illustration of infernal agency than the feeble "bullicami" of Viterbo.‡ In our own day the chief features of the Tuscan escapes of hot gases impregnated with mineral acids have already been described by Mr. Babbage in Murray's 'Hand-book of Central Italy,' and subsequently they have been connected with a geological sketch of other parts of Tuscany by Mr. W. J. Hamilton, Sec. G.S.§ In order, however, to render my own view clear, I must offer a slight outline of the chief phenomena.

In addition to other substances, the hot vapors of Tuscany are charged with boracic acid, known elsewhere only in the active volcano of Stromboli. For the extraction of this last mentioned salt, the extensive works of M. Lardarel have been entered upon at the following nine localities, viz.: Lardarello or Monte Cerboli, Lustignano, Monte Rotondo, Sasso, Il Lago, Castel Nuovo, St.

* From the Quart. Journ. of the Geological Society, vi, 367, November, 1850.

† For Italian descriptions of the Lagoni, see *Gio. Targioni Tozzetti*, Viaggi; *Repetti*, Dictionario fisico, &c. della Toscana, tom. iii, p. 369; *Bartolini*, Atti dei Fisio-critici, tom. vi, p. 335; *Mascagni*, Commentario (Siena), 1779: *Guerrazzi*, Contin. dei Georgofili, tom. ii, p. 435; and *Repetti*, Dizion. fisic. stor. ec. della Toscana, tom. ii, p. 624, tom. iii, p. 374, and Continov. degli Atti dei Georgofili, tom. xi, p. 49.

‡ See Lyell's Principles of Geology, 7th ed. p. 243.

§ Quarterly Journal of the Geological Society, vol. i, p. 296

Federigo, and St. Ippolito. These places are all situated in that elevated northern portion of the Tuscan Maremma which lies on the left bank of the Cecina. Thence the affluents of that river (the Pavone, Posera, Trossa, and Sterza) flow northwards; whilst the Cornia and its feeder the Melia run down to the Mediterranean in a westerly and southerly direction. The tract, penetrated at intervals by the hot gases, has a length of about eight geographical miles from N.N.W. to S.S.E., and a breadth of about five miles from W.S.W. to E.N.E.; the whole being comprised within 43° 8′ and 43° 16′ N. latitude.

Subtended generally on the E. and N. by the Cecina, this hilly tract, which is much fissured from N. 15° W. to S. 15° E., is separated on the east from the deep valley in which that river runs by a lofty ridge extending from Monte Castelli on the N.N.W. to the Gerfalco mountain on the S.S.E.; whilst another but lower ridge parallel to the above, is seen upon the western side of the gaseous district passing from Monte Rufoli to Lustignano, whence it slopes down to the sea-coast between Leghorn and Piombino. The gaseous vents occur therefore in an elevated and broken trough, on lines more or less parallel to the older flanking ridges. The general character and age of the sedimentary deposits of this region have been recently explained by myself.* It is enough then, for my present purpose, to state, that although the adjacent and undulating hills and valleys abound in marls and sands of tertiary subapennine age, and that to the south the lowest member of these accumulations is charged with coal of miocene age, the upland tract now under consideration, and from which the boracic acid fumes issue, is chiefly composed of the rocks called Alberese and Macigno. The latter containing *Nummulites*, represents, in my opinion, the eocene, and the former belongs to the cretaceous system. Professor Pilla enumerates, indeed, cretaceous fossils found in these hills, whilst the still higher ridge on the east of the tract which terminates southwards in Monte Gerfalco, as well as the ridges of Monte Calvi and Campiglia on the west, are both of jurassic age, the *Ammonites Conybeari*, Sow., and *A. costatus*, Schlth., occurring in them.

All these sedimentary rocks, from the jurassic to those of the eocene group inclusive, have been penetrated, and for the most part much altered, by igneous or plutonic rocks, the greater number of which have a serpentine character, their prevailing direction being equally N.W. by N., and S.E. by S. Upon entering this elevated tract from the north, I found that its chief town, Pomarancia,† was situated on a plateau of shelly, tufaceous, yel-

* Quarterly Journal of the Geological Society, vol. v, p. 276, *et seq.*

† Pomarancia is the chief residence of Count Lardarel, the spirited and hospitable proprietor of the boracic acid establishments.

lowish, sandy marlstone—in parts a travertine. This band clearly overlies the subapennine marls of the adjacent hills and valleys on the north, in which the rock salt and springs of Volterra occur, and is probably of the same age as the uppermost yellow marine 'panchina' of Tuscany, or as the lacustrine deposit in the valley of the Elsa, which I have alluded to in a previous memoir.* Charged with land and freshwater shells, this rock is disposed in horizontal masses, and denuded into abrupt escarpments, which in the middle ages formed the natural defences of the old feudal town. This tertiary deposit occupies the tract between the picturesque heights of Rocca Sillana on the east, the hot springs of S. Michele on the west, and Monte Cerboli on the south, where rocks of serpentine and gabbro rise up through strata of whitish grey alberese limestone and some contiguous schists and sandstone. It is near the junction of the intrusive rocks of serpentine with the depositary strata, which are there much contorted and broken, that certain hot springs appear, four of which, at Monte Cerboli, have recently been made known and their contents analyzed by Professor Targioni Tozzetti.† His observations and analysis are of geological importance, inasmuch as they show that those springs which appear at intervals between Monte Cerboli (Mons Cerberus?) and Lardarello, where the vapors issue, define a line, as he says, from N. to S. (but accurately N. and by W., S. and by E.,) and that essentially the springs contain, though in different proportions in each, the same ingredients as the lagoni or vapors to the south of them. Thus exclusive of organic and bituminous matter, all the wells contain chlorid of sodium, carbonate of lime, the sulphates of lime, magnesia, and alumina, with boracic and silicic acids. All of them are charged with carbonic acid gas, and one of them with a minute portion of sulphuric acid gas.

The spot now called Lardarello, where the new establishment has been built, is that portion of the valley rising from Monte Cerboli and watered by the Posera from whence the hot vapors escape by orifices, which like the mineral springs, mark a a line from N. by W. to S. by E. (fig. 1.) The sides of this valley consist chiefly of alberese limestone and schists, with some points of protruding serpentinous rocks, the lower slopes being partially covered, as far as observation was possible, with

* Quart. Journ. Geol. Soc. Lond., vol. v, p. 294.

† Delle aque-termo minerali de Monte Cerboli. Firenze, 1846. Estratta della Gazzetta Toscana delle Scienze Medico-fisiche, An. 4, 2, 1. In this memoir the reader will find indications that the vapors of boracic acid had no issue in the beginning of the sixteenth century. See also notice of this tract by the early geological traveller, Targioni Tozzetti (Viaggi), whose descendant, the living Professor of Chemistry in Florence, has also published analytical descriptions of the waters of Monte Alceto, Rapolano, Monte Catini, Castrocasa, Cimiano, and Casale.

Since writing the memoir I have been informed by Dr. Daubeny that the boracic acid vapors contain nitrogen gas—thus sustaining his views on the origin of volcanic action.

1. *Lardarello and the Soffioni seen from Monte Cebero. Looking S. by E., Lardarello buildings seen three-fourths of a mile off.*

a, a. Alberese and macigno. *b.* Gabbro rosso.

younger marls. But whilst these rocks flank the fissure on the E. and W., it is quite open, as before said, to Monte Cerboli and its hot springs on the N. by W.: it also leads through undulating ground to Bagni a Morbo, about a mile distant to the S. by E., where hot mineral waters also exist. The present lagoni are artificially formed on those points where water and earth are applied to the escapes of the intensely hot vapors. Partially repressing the issue of heat, by throwing on earth and clay, and thus controlling the size of the orifices, human agency forms active mud volcanoes, the number of which and their successive operations are regulated at pleasure. From the limited space in this valley of Lardarello, so irrigated and operated upon, various columns of vapor are seen rising to different altitudes, at different degrees of intensity. This perforated ground is in a continually chaotic state from the countless changes it undergoes; and its outlines are indeed so constantly varying by the formation of fresh outlets of gas, that the traveller who should venture among its mazes without an experienced guide would be exposed to great danger. Even the workmen occasionally lose a leg, and sometimes life, when they incautiously tread upon a covering of earth too thin to prevent their sinking into a hot abyss. The orifice which I best examined was perfectly circular, about fifteen paces in diameter, and at the most active moment of ebullition. Throwing up large globules from its bubbling surface, the heated matter is ever making an effort to overflow the rim of the little crater.* Wherever the subterranean vapor escapes from a

* In his description of the Hawaiian Islands of the Pacific, Mr. Dana accounts for the absence of active eruption and projection of materials into the atmosphere, by the great dimensions of the chief crater, in which the molten matter having a very wide vent, undulates with little or no noise, and quietly overflows its lip from time to time. [To this cause, as even of more importance and partly the cause of the size and character of the vents, Mr. Dana adds, the peculiar fluidity of the lavas.—Eds. Am. J. Sci.]

crack more or less vertical, and which presents no impediment, the muddy liquid rapidly attains its maximum heat, which is so intense, that, as M. Lardarel, Jun. informed me, no instrument had yet been made to measure accurately the maximum heat beneath the surface.* It is probable that no active volcano exhibits greater heat at any point where a test can be applied. Twenty-four hours of this process suffice to saturate the bubbling mixture with boracic acid, and the stuff is then run off into flat cisterns at a lower level. The fluid is there reduced to a third of its volume by evaporation, hastened by the hot vapor being conveyed in tubes beneath the salt-pans, and thus saving the former cost of a great consumption of fuel. After the addition of soda, the desiccation proceeds, and crystals of boracic acid are formed. The violence with which the hot gas issues from any crack, provided it be vertical, is such, that if stones of some weight are thrown upon a narrow gush of it, they are heaved up several feet into the air, and heavy flagstones are required to repress the eruptive agent, and conduct a current of it down to the drying houses and pans.

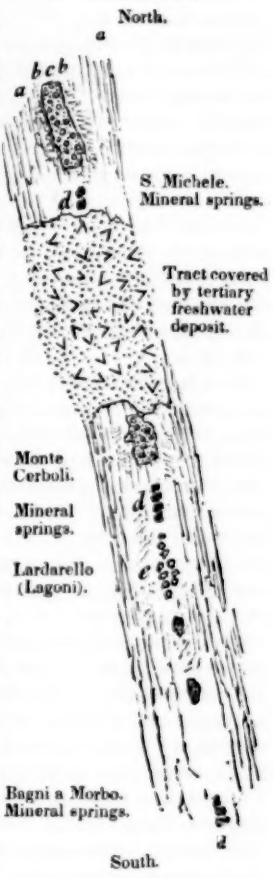
It is highly interesting to compare the present issues of the hot gases and the forms of the lagoni, as arranged and controlled by man, with their natural appearance upwards of eighty years ago, when examined and described by Targioni Tozzetti. The thick white and hot sulphurous clouds rising by fits and starts,—the occasional jets of liquid rising from the boiling cauldrons,—the large and brilliant globules as they burst,—the circular shapes of the lagoni,—the incrustations of sulphur on their banks,—the crackling of the light pumiceous and hollow ground under foot,—the conversion of the contiguous alberese limestone, then considered a primary rock, into a farinaceous or mealy state,—the fumes serving as a true barometer to the neighborhood,†—the perfect salubrity of the spot to animals, though plants are there withered and blasted;—all these phenomena are nearly the same now as when our predecessor described them. But, on the other hand, some of the former phenomena are no longer recognizable. There is no more a countless number of lagoni. We cannot now, as Targioni did, look into dry cavities from which hot blasts only issued, with noises as if from a hundred bellows, and distinguish them from those holes which were then naturally filled with boiling muddy water, discharging gas; for the manufacturer now utilizes all the hot gas, and by the addition of water makes

* Targioni Tozzetti, the old writer, does not pretend to have ascertained the extreme heat of the vapor; but Professor Pilla, on what authority I know not, places it at 140° Reaumur.

† In rainy weather, or when change is coming on, the vapors cling to the earth with increased subterranean noise, and in settled fine weather they rise to a great altitude.

gaseous orifices into mud volcanos. Nor can we any longer recognize a hot lagone approaching to the diameter of sixty *braccie*, which Targioni gives as the maximum size; still less have we a little island floating in such a hot lake. The noises and reverberations in the caverns, which he compared to the beating of a hundred fulling-mills, were doubtless much more overpowering formerly than now, when the apertures are so much closed in, and the issue so regulated. We learn, however, from the above-mentioned faithful historian two points of importance in the consideration of these forms of volcanic action:—1st. That although the lagoni were then said to be increasing in number, one of the orifices at Monte Cerboli, and another at Castel Nuovo, had ceased to act in his time. 2ndly. That flames were said to issue by night.*

2. *Ground plan.*



a, a. Alberese and macigno (cretaceous and eocene).
b, b. Altered alberese and macigno.
c. Gabbro rosso.
d. Thermal springs.
e. Lagoni or Soffioni.

That a connection exists between the Soffioni and the former geological eruptive agency of Tuscany is apparent, the moment we collate the present and the former phenomena. The inference is indeed determined by an appeal to the very line under consideration. (see fig. 2.) Beginning at the north by west, we see at S. Michele a copious outburst of serpentine and gabbro, and with it much contortion and rupture of the contiguous alberese limestone; and just at this junction, the hot springs of S. Michele, celebrated for many ages for their medicinal virtues, have their issue. Proceeding thence over undulating ground, for the most part occupied by tertiary tuff, we again find at Monte Cerboli (Mons Ceberus) on the S. by E., a like conjunction of similar eruptive rocks and dislocated strata, and with them the issue of the before-mentioned hot-springs. Thenceforward to the S. by E., the

* Targioni Tozzetti quotes Ugolino da Monte Catini's description of the fumes at Castel Nuovo, near to the baths of Bagni a Morbo, and cites his omission of any allusion to those of Monte Cerboli as an indication that the latter have burnt out since that time.

connection alluded to becomes much more interesting; for, as before said, four hot springs boil up *in the same linear direction*, and it is important to remark, that of these, the spring which is nearest to the lagoni partakes most of their boracic character. In short, the springs and the Soffioni charged with sulphuric, carbonic, and boracic acid, issue upon the very same line; and in following this line a little further to the S. by E., we reach Bagni a Morbo, where hot sulphureous springs issue from fissures in rocks similar to those of S. Michele and Monte Cerboli. Still further to the S.S.E. the boracic acid fumes reappear in a remarkably picturesque cleft of the rocks of macigno, at Castel Nuovo, where the linear direction of the vents is very striking.*

We have thus along a distance of about six or seven English miles from N. by W. to S. by E., the clearest possible evidence that the present hot springs and vapors issue upon a line of fissure, in the alberese and macigno formations, which was formed in very ancient times, *i. e.*, as I believe, between the eocene and miocene periods; the production of such fissure having been accompanied by the outburst of great bosses of serpentine and other plutonic rocks.

By extending this observation I perceived that the other "Soffioni" of this tract exist under similar conditions, showing either the actual outburst of hot springs and vapors along such line of former eruption, or the close parallelism of the two lines of phenomena. Thus, in my journey to the miocene coal tract of the Maremma before described,† I found the little town of Monte Rotondo to be built upon a junction of serpentine with the sedimentary strata it had traversed; and in looking from that spot to the N. by W., I saw the vapors of Soffioni, which bear the same name, issuing, like those of Lardarello, from a valley encased in flanking ridges of the same hard rocks. Again, the sulphureous lake, about two miles west of Monte Rotondo, having a major ellipse of north and south, is distinctly a prolongation of one of the numerous cracks extending thence to the N. by W. towards Lustignano, by which boracic acid escapes.

In mentioning these "Soffioni," Professor Pilla‡ has specially described those of Sasso, and although he has not noted the coincidence on which I lay so much stress, any one who refers to his wood-cut representing the issue at Sasso, will see that the line of vapor issuing from cavities is parallel to the main direction of the encasing ridges.§ Now, these ridges of alberese and macigno

* This is well described by Targioni Tozzetti.

† See Quart. Journ. Geol. Soc., vol. v, p. 292.

‡ Trattato di Geologia, p. 282. Pisa, 1847.

§ I cannot but express a hope that Mr. Babbage will at some time give to the public a copy of the suggestions he furnished to the Grand Duke of Tuscany, for the extension of the useful employment of these hot gases, which might thus serve to convert a barren tract into a wealthy manufacturing district.

have either a dominant direction from N. by W. to S. by E., or are perforated along such line by the serpentine, granitone (greenstone), or other eruptive rocks, including gabbro, to which I shall afterwards advert; and hence it appears, that the ancient lines along which nature expended some of her grandest energies in this region, are also those along which she still manifests the present escape of hot springs and gases. Again, these hot gases still produce, though on a small scale, those conversions or metamorphisms of the strata on the sides of their escapes, which the geologist can well understand to have operated more largely and powerfully at that period when great masses of serpentine and other igneous rocks were evolved (or strove to be evolved) under enormous pressure, through the younger secondary and oldest tertiary deposits. At Lardarello, for example, small portions of the ordinary alberese limestone have been and are still converted into sulphate of lime by the action of sulphuric acid fumes; and the schistose calcareous shale is baked by the intense heat into brittle porcelain rock of a red color. But I would here observe, that in these recent and partial metamorphoses by natural causes, as in those of ancient date, traces of the original lamination or stratification are nearly always perceptible in the lumps or masses so affected or altered.

Gabbro Rosso.—The last observation leads me to offer some remarks on the nature and origin of the "gabbro rosso" of the Tuscans; for after an attentive examination of this rock throughout the tract immediately to the north of the boracic acid country, I feel compelled to express my dissent from the opinion of Professor Paul Savi, in which my friend Mr. W. J. Hamilton in his description of the geology of Tuscany has coincided. The chief masses of "gabbro rosso" lie in the tract south of Pisa, and east and southeast of Leghorn, which is bounded on the north by the valley of the Arno, and on the south by that of the river Cecina. The varieties of this rock are instructively exhibited in the ridges of alberese and macigno, which form the east and west sides of a longitudinal depression occupied by subapennine marls, that extend from Salveti near the Pisan valley on the N. by W., to the valley of the Cecina on the S. by E. The direct road from Pisa to the Maremma is conducted along this depression. The westernmost of these ridges, which forms the bold coast, south of Leghorn, containing much granitone, serpentine, and other varieties of eruptive rock, also exhibits, particularly along its eastern face, a good deal of the "gabbro rosso," which, as Professor Pilla informed me, obtained this name from the village of "Gabbro," a few miles southeast of Leghorn, which is built on the summit of a conical hill composed of such rocks;—I say rocks called "gabbro," because I shall presently show, that two rocks of entirely different origin have been united under this one name.

The eastern or inland ridge rises boldly up into the mountains which proceed from the north of Monte Vaso to Castellina Marittima on the south, and it is in reference to this group of hills, on the eastern part of which Monte Catini is situated, that I specially call attention, as it affords ample materials for settling the question which has arisen between Professor P. Savi and Mr. W. J. Hamilton on the one hand, and the late Professor Leopoldo Pilla and myself on the other. The two former have endeavored to show that whether in its globular and amorphous form, or in its thin-bedded state,* the rocks they call "gabbro rosso" are metamorphic; whilst Professor Pilla and myself contend that the amorphous, variolitic gabbro must have been erupted in a molten state, whether we consider its composition and unbedded condition, or the part it has played in protruding through, overturning, breaking, and altering the pre-existing strata. And although my deceased friend Pilla has to a certain extent published this opinion, he has not sufficiently illustrated his views, and I am therefore the more anxious to do him justice, and to adduce some of the reasons he assigned when we visited the tract together. The opinion of an attentive and lively observer of igneous action like Pilla, a Neapolitan by birth, who during many years was occupied in examining Vesuvius, is surely entitled to much consideration in determining such a question, even had not the physical and geological relations of the phenomenon seemed to me quite conclusive. Between Castel Anselma and Civito Castellina, I inspected natural sections, where the gabbro had not only penetrated the alberese limestone, but had thrown it off in shreds, contorted fragments, and folds on the sides of the eruption. Now, the red gabbro which had manifestly thus acted was entirely an unbedded, amorphous, felspathic mass, for the most part made up of spheroidal concretions having a variolitic structure, *i. e.* with small pustular or globular surfaces in each of the folds or concentric layers into which the large nodules exfoliate. This variolitic surface was specially pointed out to me by Pilla as a proof of the rock having been in complete fusion; inasmuch as the same forms occur frequently in ancient plutonic rocks and in the modern volcanic products of Vesuvius. The rock is, besides, often cellular and amygdaloidal as well as veined, like some of our earthy Scottish traps, occasionally containing crystals of carbonate of lime, analcime, and also the peculiar mineral caporcianite, a variety of stilbite. Chemically considered, this rock is little else than a variety of greenstone. In other words, it is one of those products, accompanying greenstone and serpentine, which has been much impregnated by iron, and which under the blowpipe melts as

* See Mr. Hamilton's translation of Savi's description, Quart. Journ. Geol. Soc., vol. i, p. 288.

easily as wax. This is the "gabbro rosso," which I consider to be a true eruptive rock, and which rises up into an amorphous

3.

a. Alberese. *b*. Alberese with mineral veins. *c, c*. Gabbro rosso.
d. Miocene? with alabaster. *e, e*. Subapennine.

mountain mass at Civita Castellina, where it performs, as above mentioned, the part of an intrusive agent. It there throws off on its eastern summit the alberese limestone in a highly fractured and mineralized condition, as seen in fig. 3. From the natural section here exhibited, it is certain that this eruption of "gabbro" took place after the consolidation of the alberese and macigno formations, *i. e.* after the younger chalk and older eocene. It is also further evident that another movement of elevation occurred after the miocene period; for not only is the limestone associated with white marls to a great extent loaded with alabaster, which some persons might infer was altered limestone, but the whole of this mass has been considered to be miocene, simply because it dips away from the alberese and gabbro in such inclined strata, and is thus placed in striking contrast with the subapennine or pliocene marls of the valley which surround a boss of "gabbro rosso" in perfectly horizontal and unbroken layers. The altered alberese at Civita Castellina has here and there serpentinous soft bands, and bears a metamorphic aspect, with a slickenside surface, accompanied by cracks and numerous veins of arragonite, all of which specially abound near the junction of the alberese with the "gabbro." Copper veins, however, either traverse the alberese or run down its junction with the gabbro; and are therefore of date posterior to the eruption of the latter. It is indeed the opinion of Pilla, that the copper veins have resulted from the same igneous action which evolved the "gabbro rosso," and are contemporaneous with that rock, whilst other authors contend that they are posterior to it. In traversing on foot the wild ridges which separate Civita Castellina from Monte Catini, where the richest copper ores abound, I witnessed repetitions of the chief phenomena above alluded to, in which, besides "gabbro rosso" and feldspathic trap, (the epidosite of Pilla), there were other rocks of this class both of greenish and purple colors, which I should class as greenstone and serpentine. All these amorphous masses, however diversified in aspect and structure, seemed to me to form parts of the same eruptive matter which has penetrated the macigno and alberese in lines running N.N.W. and S.S.E.

At Monte Catini, where Mr. Hamilton seems to have most studied it, the gabbro rosso appears in a bold promontory fronting the valley of the Cecina on the south, and Volterra on the east. The chief mass is here the same amorphous spheroidal variolite as in other places. Partially, indeed, it assumes still more a serpentinous appearance; the dull red globular lumps and spheroids being often enveloped in greenish coatings. It is not my province to allude to the splendid veinstones of copper,* occasionally quartzose, which ramify along its edges or through this "gabbro;" I content myself with saying, in reference to the point at issue, that in numerous galleries and cuttings the clearest proofs are exhibited of the homogeneity of structure of the amorphous gabbro, and of the total absence of any thing in it like original aqueous deposit. In this respect it bears no resemblance to any other metamorphosed stratum which ever fell under my notice. The variolitic arrangement of the spheroids is very striking. On exfoliation, they exhibit the pustules before alluded to on the external surface only of each concentric fold, and they fall to pieces exactly like "basalte en boule." But besides this rock, —which is the "gabbro" proper, and plays the same part in relation to the sedimentary strata as the granitone and serpentine and other adjacent rocks of a similar origin,—there is a rock also called "gabbro rosso" by Savi and Hamilton, which abounds on the eastern flank of Monte Catini and other places, which is not only totally dissimilar in composition and form from that which has been described, but which I admit is clearly a metamorphosed stratum.

This is a jaspidified red and green calcareous schist, marked by numerous thin laminæ of deposit, which is evidently nothing more than the argillo-calcareous portion of the alberese or macigno formations, which happened to be contiguous to the true gabbro when the latter was erupted. For it is plain that the amorphous gabbro (as seen in a very clear natural section) has twisted back these finely laminated jaspideous strata upon themselves at a point of eruption. That in perforating, bending back, indurating, and dislocating the schists, the intrusive matter should have communicated its color, and to some extent its mineral composition, to the argillaceous and calcareous strata thus affected by it, is nothing more than must be looked for, and is indeed frequently found to be the case under similar geological conditions. This appearance of transition, from what must be granted to be true altered sedimentary layers into the amorphous spheroidal "gabbro," has led Savi and Hamilton to think that the spheroidal red gabbro is simply a still more highly fused or altered accumulation of the

* As a wayfaring geologist, I was most hospitably received at his villa by Mr. Sloane, the intelligent proprietor of the copper mines of Monte Catini. The ore is very peculiarly diffused and merits a special study.

same aqueous matrix. When, however, we recede from the immediate point of contact, we have not only very different forms in the matrices of the altered and the eruptive rocks, but an essential difference of composition and structure. Pilla has indeed cited instances just as notable of the conversion or metamorphosis of the strata by gabbro rosso, as by granitic, pyroxenic and porphyritic rocks.* One of those examples is seen in the spot called Botro del Ribuio near Serazzano, where the spheroidal "gabbro rosso" has thrown the strata of macigno into a vertical position, and has changed them into jaspers of blood-red color, highly charged with silex and oxyd of iron.†

If, indeed, the argument about transitions from the rock which has been the agent of alteration into the strata which are altered, be admitted, we must re-open elementary questions in the physics of geology which I had supposed were long ago set at rest. We may in that way be led to abandon many conclusions at which we had arrived, in refuting the doctrine respecting certain rocks of Cornwall, Norway, and other tracts which were believed by some authors to prove transitions from granites to slates, and thus to indicate a common origin of these two classes of rock! If this method of reasoning be again entertained, (as it seems to me it is by M. Savi,) then many of the inferences which geologists have drawn concerning the posterior intrusion of granite and other igneous rocks amid depositary strata will be invalidated. For, although there are numerous examples of such phenomena, which no skeptic can assail, still there are frequent cases where it is impossible to define the precise limit between the erupted molten matter and the altered rock. It is indeed in the very nature of the phenomenon that such should happen, and the time of practical geologists can be better employed than in disputing upon such points. Some persons may indeed argue that many varieties of traps and amygdaloids were to a great extent evolved from the melting of the preëxisting strata in the crust of the globe, and I am quite ready to admit that such may have been the case. But this admission by no means removes them from that class of true eruptive rocks which, in the eye of the geologist, have acted mechanically upon the strata they have penetrated; for even some of the lavas of Vesuvius may be, in great part, fused and melted materials, formerly accumulated as marine sediment, which have been transmuted by intense heat under pressure. The practical

* In his "Richezza Minerale della Toscana," Pilla unites the "gabbro rosso" with the other ophiolitic or serpentine rocks, which having acted as partial centres of elevation and eruption, rise up as conical, elongated, and rugged mounts, detached from one another (p. 39). He describes the copper of Monte Catini as lying in a true vein, which has the peculiarity of being contemporaneous with the associated gabbro, both of which are posterior to the sedimentary strata (p. 40).

† Trattato di Geologia, Part I, p. 510.

point, therefore, for which I contend is, that the amorphous and spheroidal "gabbro rosso" of the Tuscans is from its composition, and still more *from the geological part it has played*, a true plutonic and eruptive rock; whilst the red jaspidified schists, which have been also termed "gabbro," are nothing more than sedimentary strata altered by the heat attending the eruption of the adjacent masses.

Lines of former and present disturbance.—As it is along the lines of eruption of the serpentines, greenstones and gabbro, *i. e.* from N. by W. to S. by E., that nature has been repeatedly laboring to evolve heat in the west of Tuscany, so also have the secondary rocks been alienated and altered in this direction. It is on the same line that the granitic rocks of Piombino have subsequently uprisen, the average direction of the whole of the coast of this part of Italy being parallel to it.*

Further, it is on this line that the various Soffioni or vapor volcanos issue, and that earthquakes still affect most the surface. Those who would wish fully to comprehend the phenomena attendant upon the earthquake which last agitated the west of Tuscany, and particularly the tracts south of Pisa, should consult the descriptions of Professors Savi and Pilla. In accompanying the latter from Pisa to Civita Castellina, and in thus passing from N.N.W. to S S.E. along the depression in the subapennine marls, which lies between the ridges above described as penetrated by serpentine, gabbro, and other eruptive rocks, I was struck with the fact that the most powerful vibratory disturbance occurred in the low hills and hillocks of incoherent materials along this very line. The shocks from north to south being most powerful in this parallel of longitude, it was natural that they should produce the most disastrous effect in that portion of the tract where edifices were placed on slightly coherent marl that rises into hillocks void of lateral support. The buildings which rested on the adjacent harder rocks of alberese, gabbro, serpentine, and greenstone, were comparatively unaffected, whilst those which stood on marl had fallen or were much shattered. It is further worthy of notice, that in the deepest denudations among the hillocks of marl, particularly near Lorenzana, where the earth opened into chasms, subterraneous waters which had been hitherto imprisoned rose suddenly to the surface; just as if artesian wells had been sunk, and that the overlying crust of a basin had been broken through. Spouting forth sand and mud, these jets of water so threw out solid contents, that when dried up they resembled so many mole-hills with radii; the centre or box of each wheel-shaped body being composed of concentrically laminated sands, marking the

* Pareto, Pilla, and the Italian authors show that the granite of Piombino and Elba cuts through the serpentine.

point at which the water issued. These appearances not only served to explain the origin of the larger muddy bosses of similar form, common in the incoherent subsoils of Calabria, which have been so frequently subject to great earthquakes, but may also be viewed as another link which connects the present small disturbances of the surface, with the former powerful subterranean energy proceeding from igneous and gaseous development we have been considering.

Thus, in reference to my preceding memoirs and in reasoning by analogy, we are led to infer, that the great evolution of molten matter in former or plutonic times, accompanied by so much heat and its gaseous attendants as to metamorphose whole mountain chains, was succeeded, as the bottoms of the sea rose, by a considerable diffusion of volcanic materials, chiefly of subaqueous origin, but in part subaërial; and that, finally, the lands assuming their present relations to the sea, the extension of molten matter has been confined to a very limited number of fissures or vents of eruption, many of which have become extinct with the lapse of time. A portion, however, of these eruptions in Europe is still in continuous activity, whether in emitting solid matter, as at Stromboli, or hot springs and vapors, as in the Tuscan Soffioni; whilst another portion is intermittent, as viewed in the paroxysmal outpourings of Etna and Vesuvius, the occasional formation of small new cones and craters under the waters of the Mediterranean and the fitful lines of earthquake shocks with their accompanying outbursts of water.

In viewing the intimate connection between all these phenomena, and in looking to the powers of the Soffioni of Tuscany, we might perhaps infer, that if these gusts of heat were entirely repressed by closing up the orifices through which they now escape, earthquakes to some slight extent might be expected still more to prevail in the neighborhood, until the expansive forces were liberated; just as the most calamitous shocks in Sicily and Calabria have occurred when Etna has been most dormant. Putting aside this speculation, the hot vapors may unquestionably be viewed as the remains of former igneous action, which I believe to have been incalculably more powerful, not only because it is on the same band or its subordinate parallels that the copious masses of plutonic rocks of this tract and the adjacent mineralized strata occur, but because this line is absolutely coincident with the axis of the Carrara and other marbles and their associated slates and crystalline rocks of the Apuan Alps. Now, as those lofty masses or western Appennines, together with their lower parallels in the Gulf of La Spezia, have been shown to be simply altered strata of jurassic age*; so in extending our observation in the same line

* See Quart. Journ. Geol. Soc., vol. v, p. 266 *et seq.*

further to the N. and by W., we find that serpentinous rocks have there, as in the Tuscan Maremma, burst through alberese and macigno and in much greater volume. In truth, the copious serpentines and their accompaniments in and around the territory of Genoa, have converted the cretaceous strata into rocks having all the appearance of palæozoic slates and flagstones. Other and posterior movements have there also affected, though for the most part mechanically, the contiguous conglomerates and sandstones of miocene age, which on the sides of the pass leading from Genoa to Alexandria occupy very highly inclined positions. The phenomena in the Genovesato and Piedmont, like those in the Tuscan Maremma*, indicate that such beds of the middle tertiary age, whether marine or freshwater, have been dislocated along those lines of disturbance, which at an antecedent period had been marked by the protrusion of the serpentinous rocks in a molten state. In other words, it was by the post-eocene eruption that the great metamorphosis of the pre-existing strata was caused. A long period of comparative repose followed, one of the earliest operations of which was the accumulation of miocene conglomerates, for the most part made up of strata previously altered by the serpentine eruptions; as seen in the hills north of Genoa and Savona on the one hand, or in the Monferrato (Superga) on the other. Another powerful disturbance subsequently took place, when these miocene beds were thrown upon their edges, or were fractured and highly inclined along the same general lines of fissures, which had been marked by a more intensely igneous activity in the previous or serpentine period.

Although the phenomena chiefly treated of in this memoir have reference to a great band of disturbance proceeding on the whole from N. N. W. to S. S. E. along a length of about 100 miles and a breadth of about 25 miles, a glance at the geological map of Italy by Collegno, combined with my knowledge of the country, has led me to think, that whilst this line of eruption contains within itself minor parallels, there are other and divergent lines, along which similar strata have been affected by the same eruptive rocks. The country of north-western Italy, which comprehends the Genovesato and the north of Parma, seems to have been the grand centre of serpentine eruption, from whence such lines radiate as marked by the protrusion at intervals of igneous rocks and the bands of metamorphosed strata which constitute the loftiest ridges of Italy, (see fig. 4, p. 215.) In this way, the serpentine bosses of the Appennines, between Bologna and Florence, that trend from N. W. to S. E.—*i. e.* from the region of chief eruption—though divergent from the line of the Apuan Alps, and Tuscan Maremma, are exactly coincident with the

* See former Memoir and Section Quart. Journ. Geol. Soc., vol. v, p. 283 to 292.

major axis of the Appennines or great back-bone of Italy, the culminating points of which, as at the Gran Sasso d'Italia, 9530 feet above the sea, are composed of eocene (nummulitic) and cretaceous rocks reposing on jurassic.

Again, if we turn from the east and look to the other great band of eruption to the west of the coast of Italy, as marked by serpentines protruding through the cretaceous and eocene deposits of Corsica, we see (as graphically laid down by Pareto*) that it marks nearly a meridian line. Looking then at Italy on the great scale, the geologist may, I think, satisfactorily connect its dominant physical features with former causes of upheaval. He sees that, as it is in the highly convulsed and broken-up region where the Appennines bend round to become confluent with the Alps, the greatest masses of serpentine have been emitted, so, exploring southwards from this grand focus, he observes that *bands of the same molten matter have been intruded into divergent cracks and fissures* in the crust of the earth, and extend in long linear directions to the S.E., S.S.E., and S. Geological investigation establishes, indeed, not only this fact, but also the important point, that such igneous matter was simultaneously emitted; since it has alone broken through and metamorphosed sedimentary strata of the same age through several degrees of latitude. Now, as few parts of Italy contain strata of higher antiquity than liasso-jurassic, and as there is no evidence that its submarine accumulations had ever been raised into dry land before the cretaceous and nummulitic rocks were accumulated upon them, we have a fair right to infer, that the linear eruptions of serpentine and their accompaniments of gas and heat, absolutely furnished the Peninsula with those chains of hard and altered strata (each containing subordinate parallels) whose features and contents have been described on a previous occasion. In short, there is no reason to believe that Italy had any well-defined terrestrial existence until the period of the post-eocene serpentinous eruptions. As Corsica, however, is only the northern prolongation of Sardinia which contains Silurian fossils, and as both islands are characterized by a meridian chain of ancient crystalline rock, it is clear that a very ancient mass of land ranged in that direction, as further proved by its old crystalline Silurian rocks being overlaid by palæozoic coal plants and a coal formation.† It is certain, therefore, that the serpentinous eruption

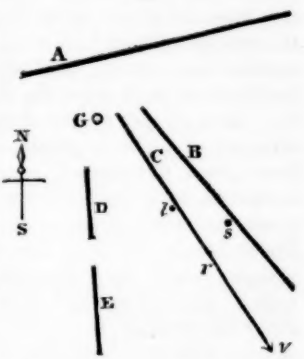
* The reader who wishes to become acquainted with the various lithological characters of the rocks classed under the head of Serpentine, and which were all emitted at the post-nummulitic period, must consult the works of Pareto on Liguria Marittima, and on Corsica, both illustrated by excellent geological maps. Although the Marquis Pareto, following preceding authorities, has classed the nummulite limestone with the chalk, I trust he will now agree with me.

† After this memoir was read, Professor Meneghini of Pisa, communicated to me, that Professor Savi and himself had discovered undoubted species of coal plants

there found its issue along a line of fracture coincident with the north and south direction which had been impressed upon these lands at a very remote period—such eruption, though divergent from them, being simultaneous with the chief axes of upheaval in Italy.

In speaking of divergent lines of fracture and elevation, which offer proofs of simultaneous eruption and dislocation, I am led to terminate my communications on the Alps and Appennines, by calling attention to the great phenomena which are common to these two chains and at the same time distinguish them. To render my idea clear I have annexed the accompanying diagram, fig. 4. Whilst the direc-

4.



A. Alps—major axis.—B. Appennines.—C. Apuan Alps.—D. Corsica.—E. Sardinia.—G. Country of Genoa, serpentine rock.—*l*. Lagoons of Tuscany.—*r*. Roman Volcanoes.—*s*. Gran Sasso—*v*. Vesuvius.

(*Pecopteris arborescens* and *Annularia longifolia*) in anthracite schists, which on the right bank of the Era near Volterra form the lower part of the "Verrucano," or oldest conglomerate of Italy. A communication to this effect, on the part of his colleagues, was at the same time made by Professor Parlatore at the late meeting of the British Association at Edinburgh. This important discovery seems to prove that a lower portion of the rocks called Verrucano, which have hitherto been considered to be the natural base of the lias, is of the same palæozoic age as the conglomerates of the Valorsine and other places in the Alps. Yet still, in reference to my opinion above expressed, the plants found in Tuscany may either have been derived from lands now submerged, or from the adjacent shores, of which the Silurian and ancient crystalline rocks of Sardinia and Corsica are the existing remnants. At all events, no rocks have yet been made known to geologists in Northern or Central Italy which are of sufficient antiquity to have been the *dry land* whereon the coal plants grew, to which Professors Meneghini and Savi have drawn attention.

As Italy is thus connected still more closely with the Alps by the feature of anthracite coal plants common to both countries, I would here allude to an able recent memoir of Professor Heer (Mittheilungen der Natur. Gesellscht. in Zurich, 1850,) in which, specially referring to the case of Petit Cœur in Savoy, he argues, that the plants found there being terrestrial and of the carboniferous era, the stratum in which they are imbedded cannot be united with that which contains marine liassic belemnites. The general analogical reasoning of this author is so much in unison with my wishes, as expressed in the Memoirs on the Alps, Appennines and Carpathians (Journ. Geol. Soc., Lond., vol. v, pp. 176, 177), that I have only to regret he should have omitted to acquaint his readers, that I drew my inferences solely from the *actual section and the order and position of the beds*. I clearly stated that I did so in opposition to my desire to find the plants and belemnites lying in what might be considered separate formations. With the utmost deference to the value of organic remains, I felt however bound to affirm, that in the example of Petit Cœur, the *physical evidences* seemed fairly to sustain the views of M. Elie de Beaumont and M. Sismonda. At the same time, I did not deny the possibility (though as yet unexplained by an actual appeal to facts) of accounting for this singular collocation by an extremely sharp, inverted curvature, followed of course by powerful denudation. Lastly, I would now observe, that the naturalists who are most opposed to the views of MM. De Beaumont and Sismonda have not visited the locality, which they really must do before they can explain away by fair demonstration what they consider to be an anomaly.

tion of the chief ridges of Italy is more or less at right angles to the main direction of the Alps, we know that the greatest amount of metamorphism has been impressed on both chains after the nummulitic period; and again, that in both, very violent movements took place after the deposition of the miocene tertiary. In the chief range of the Swiss and Austrian Alps, the greatest changes of metamorphism, elevation, depression, and contortion have been determined upon lines having on the whole an east-northeast and west-southwest direction; whilst in the Appennines the same changes have occurred at the same periods on linear bands trending generally from N.W. to S.E., and even veering round to a meridian strike as they approach the direction of the ancient and palæozoic rocks of Corsica and Sardinia. Notwithstanding, however, their great diversity of direction, the Alpine and the Sardinian lines of active disturbance have each been manifested along primæval coasts, the strata formed upon which contain palæozoic fossils. When, however, we pass from the consideration of events so long past to the contemplation of those agents of terrestrial change which have been most active in comparatively recent times, the Appennines are at once distinguished from the Alps in possessing those truly volcanic phenomena which connect geology and existing history. With the most frequent evidences of recent mutations to an enormous extent in their outlines —*i. e.* since the period of the glacial waters*—the Alps present nowhere the trace of any subaërial volcano; the youngest igneous rocks being those which have traversed the older tertiary deposits of the Vicentin and other tracts. The Appennines, on the contrary, offer proofs, particularly on their western shores, not only of recent oscillations, but also of copious volcanic eruptions. Thus, as was recently shown, subaqueous volcanos were intensely active during the penultimate period, along a band parallel to and flanking the Appennines, which had been raised at a former epoch. After these fires were spent and their dejections raised up into the western lands of the Papal and Neapolitan states, we have no proofs of subaërial volcanicity until Vesuvius burst forth, save the case of the volcano of Latium†, whose period of activity is lost in the maze of time, and the notable examples among the early Greek settlements in the Bay of Naples.

Lastly, let us recollect, that in the tract of Western Tuscany, which has been the special subject of this memoir, we also read a most instructive lesson upon the efforts of *subterranean igneous forces to develop themselves at successive periods along one and the same established band of active change in the crust of the*

* See "Distribution of the Superficial Detritus of the Alps, compared with that of Northern Europe." (Quart. Jour. Geol. Soc., vol. vi, p. 65.)

† Quart. Jour. Geol. Soc., vol. vi, p. 294.

globe. For whilst one extremity of this band is marked by the eruptions of Ischia and Vesuvius, where volcanic action has prevailed in the historical period, we have only to follow such zone from Naples to the N.N.W. to see that it passes along a portion of the Papal States replete with earlier volcanos, and is directly coincident with tracts powerfully affected in much more remote periods, along one of which volcanic action is still partially developed in the hot vapor issues of the Tuscan Maremma.

ART. XXV.—*On Kirkwood's Law of the rotation of the Primary Planets;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the City of New York.

Messrs. Editors,—In the last number of the American Journal of Science, in noticing a small volume of mine lately published, under the title of "The recent progress of Astronomy, especially in the United States," you say, "One omission should be noticed. We do not find in this volume any allusion to Kirkwood's celebrated law connecting the rotations of the planets with their masses and distances from the sun. In a history of American Astronomy especially, this discovery is entitled to an honorable mention."

As the enquiry has been made from a great variety of sources, why I have omitted in my book to make any mention of Kirkwood's discovery, I seem called upon to assign a reason for this neglect.

I might perhaps shelter myself under the protection of my Preface, in which I say, "This little volume is designed to exhibit in a popular form the most important astronomical discoveries of the past ten years. *It does not profess even to enumerate all the discoveries of this period.* Such an enumeration would have swelled the volume much beyond its present size. *Those topics have been selected in which it was supposed the public generally would feel the deepest interest.*"

The plan of my work, as here stated, must be my apology for omitting to mention even the names of many professors of astronomy in our country whose reputation is not confined to the limits of the United States; but the importance of Kirkwood's law (if it be really a law of nature) is such that even this plea would not have justified its entire omission in a work devoted to the recent progress of astronomy, *especially in the United States.* I am therefore forced to confess that my reason for omitting to notice Kirkwood's law was that I was not satisfied of its truth. Having made this public confession, I am bound to give my reasons for withholding my assent to the law.

The following is the law in question, as stated by its author in this Journal, vol. ix, page 395 :—

"Let P be the point of equal attraction between any planet and the one next interior, the two being in conjunction : P′, that between the same and the one next exterior.

"Let also D = the sum of the distances of the points P, P′, from the orbit of the planet; which I shall call the diameter of the sphere of the planet's attraction ;

"D′ = the diameter of any other planet's sphere of attraction found in like manner;

"n = the number of sidereal rotations performed by the former during one sidereal revolution round the sun ;

"n' = the number performed by the latter ; then *it will be found* that $n^2 : n'^2 :: D^3 : D'^3$; or $n = n'\left(\frac{D}{D'}\right)^{\frac{3}{2}}$."

That is, *the square of the number of rotations made by a planet during one revolution round the sun, is proportional to the cube of the diameter of its sphere of attraction ;* or $\frac{n}{D^{\frac{3}{2}}}$ *is a constant quantity for all the planets of the solar system.*

The simple question for us now to consider is whether this proposition is *true.* To test it, however, is a matter of more difficulty than might be anticipated. It involves the knowledge of the distances, masses, and the times of revolution and of rotation of all the planets of the solar system. Now there is some uncertainty with regard to the mass of each of the planets ; and still greater uncertainty with regard to the times of rotation of some of them upon their axes. Moreover, between Mars and Jupiter, we find a group of planets ; and the assumed law applies to them at a time when they are supposed to have been all united in one body. Of course there is an uncertainty with regard to all the elements of this planet, and we are left to conjecture the time of its rotation upon its axis. It is then difficult to bring this assumed law to the test of truth. Under these circumstances it has appeared to me the most satisfactory course, to take those elements of the planetary system which have the strongest independent probability, and compare them with this law ; and when we find discrepancies, to enquire whether it is admissible to vary the assumed elements so as reduce them to an entire harmony with the proposed law. This I have accordingly attempted, and the result is shown in the following table, where column first exhibits the planets in the order of their distances from the sun ; column second exhibits their mean distances, that of the earth being taken as unity ; column third exhibits their masses, the sun being taken as unity ; column fourth exhibits the diameter of the sphere of attraction of each of the planets computed after the manner of

Kirkwood; column fifth exhibits the sidereal times of revolution of each of the planets round the sun; column sixth, the probable times of rotation upon their axes; and column seventh exhibits the computed value of $\frac{n}{D^{\frac{3}{2}}}$, which, according to Kirkwood, should be a constant quantity. Columns second and fifth are taken from the last edition of Sir J. Herschel's Astronomy, with the exception of Neptune, which is taken from Mr. Walker's computations, and the asteroids, which are taken from the latest orbits; column third is taken from Encke's Memoir in the Ast. Nach., No. 443, with the exception of Neptune, which is derived from Bond's observations of the satellite; and the asteroids, which I have assumed as together equal to Mars; column sixth is taken from Mädler's Populäre Astronomie, 4te Auflage, with the exception of the Asteroids, whose period is assumed at 27 hours, being the time assigned for Juno in the Edinburgh Encyclopædia, vol. ii, page 601, and Uranus, which is taken from Herschel's Astronomy, page 648.

	Mean distance.	Mass.	Diameter of the sphere of attraction.	Sidereal revolution.	Rotation on axis	C.
				d.	*h. m. s.*	
Merc'y,	0·3870981	$\frac{1}{4865751}$		87·9692580	24 5 28·3	
Venus,	0·7233316	$\frac{1}{401839}$	0·395664	224·7007869	23 21 21·93	928
Earth,	1·0000000	$\frac{1}{359551}$	0·525483	365·2563612	23 56 4·09	961
Mars,	1·5236923	$\frac{1}{2680337}$	0·651042	686·9796458	24 37 20·4	1275
Astr'ds,	2·545	$\frac{1}{2680337}$	0·562186	1488	27 0	3138
Jupiter,	5·2027760	$\frac{1}{1047.871}$	5·409019	4332·5848212	9 55 26·56	833
Saturn,	9·5387861	$\frac{1}{3501.6}$	8·546946	10759·2198174	10 29 16·8	985
Uranus,	19·18239	$\frac{1}{24005}$	7·719884	30686·8208296	9 30	3614
Nept'ne	30·0395	$\frac{1}{19406}$				

The numbers in the last column of this table are not constant, as Kirkwood's law requires, but exhibit on the other hand great discordances. Let us then, in accordance with our proposed plan, proceed to inquire whether it is admissible to vary the elements employed so as to harmonize all these numbers.

I. The greatest discrepancy is in the case of Uranus. Is it allowable to vary the elements employed in this computation, so as to reduce the value of C found for Uranus to agree with that found for either Venus, the Earth, Jupiter, or Saturn? The mean distances of Saturn, Uranus, and Neptune, cannot be materially changed; their masses are liable to some uncertainty, but not enough to vary the diameter of the sphere of attraction of Uranus by one-twentieth of its whole value. The time of revolution of Uranus about the sun is well known. The only remaining element which enters into the computation, is the rotation of Uranus upon its axis. If we assume that this planet requires thirty-seven

hours to make a rotation upon its axis, the value of C computed for Uranus will agree with the mean result derived from Venus, the Earth, Jupiter and Saturn. Mr. Walker, by employing somewhat different data, (Am. Journal, vol. x. p. 22,) has obtained a result of thirty-three and a half hours. The question therefore presented for our decision is, can we admit that Uranus requires from 33 to 37 hours to make one rotation upon its axis? I think this assumption inadmissible for the following reasons:

1. Laplace in the Mec. Cel., vol. iv, p. 356, says, "the time of rotation of Uranus is not probably much less than that of Jupiter or Saturn;" and in the last edition of Herschel's Astronomy, page 648, the time of rotation is given at $9^h\ 30^m$?

2. A similar conclusion follows from the observed figure of the planet. Sir William Herschel remarked that the disc of Uranus was sensibly flattened; and Prof. Mädler has carefully measured the diameters of this planet, which indicate a compression of $\frac{1}{9.5}$, or almost exactly *one tenth*, which is fully equal to that of Saturn, and greater than that of Jupiter.

If it be admitted that the figure of Uranus is the figure of equilibrium of a planet once fluid, (and this will not probably be disputed by the believers in the nebular hypothesis, to which Kirkwood's law is thought to have added new probability,) then we can compute the velocity of rotation of the planet upon certain hypotheses with regard to its density. According to Laplace, (Mec. Cel., vol. ii, p. 310), the limits of the oblateness of a planet are $\frac{1}{2}\,\alpha\,\varphi$ and $\frac{5}{4}\,\alpha\,\varphi$; where $\alpha\,\varphi$ represents the ratio of the centrifugal force to the force of gravity at the equator. The first limit corresponds to the case where all the matter of the planet is collected in the center; and the second corresponds to the case where the mass is homogeneous. If we suppose Uranus to make a rotation in seven and a half hours, the oblateness upon the first hypothesis is one tenth; and if we suppose the planet to make a rotation in twelve hours, the oblateness on the last hypothesis is one tenth; while on the first hypothesis it is one twenty-fifth; and for a less velocity of rotation, the oblateness in either case would be still less. Therefore, we cannot suppose Uranus to require more than twelve hours to perform a rotation upon its axis, and it probably does not require over ten hours.

3. The analogy of Uranus with the other planets leads to a similar conclusion. I shall refer to this analogy hereafter on page 222.

I do not therefore perceive how Uranus can be reconciled with Kirkwood's law, by any admissible assumption with regard to the value of its elements.

II. We find a similar discrepancy in the value of C computed for the Asteroids. Are we permitted in this case to assume elements which shall harmonize with Kirkwood's law? The re-

flection naturally suggests itself, that inasmuch as several new asteroids have recently been discovered, we must be quite ignorant of their total number; and hence if these planets were once united in a single body, there must be great uncertainty with regard to its mass and the dimensions of its orbit. It is, however, remarkable that the average distance of the thirteen asteroids now known, differs from the average of the four which were first discovered, by little more than *one thirtieth* of its whole value; which affords a presumption that we have discovered nearly the center of gravity of the system. With regard to the total number of the asteroids, we are entirely ignorant; but we may safely infer that those which remain to be discovered are quite small. According to Mädler, the volume of Vesta is $\frac{1}{234\frac{1}{2}}$ that of Mars, and that of Pallas is $\frac{1}{225}$ of Mars; in other words, the planet Mars would furnish 225 asteroids as large as Pallas. Now Pallas is certainly above the average size of the asteroids; from which we infer that the volume of all the known asteroids amounts to only about *one twentieth* of Mars. It seems then to be a very liberal allowance to admit that all the asteroids, discovered and undiscovered, are equal in volume to the planet Mars. Mr. Walker has computed (Am. Jour., vol. x, p. 22) that a planet with a mass *double* that of Mars would harmonize perfectly with Kirkwood's law. The existence of so large a mass appears to me improbable.

In order to make the value of C computed for the asteroids harmonize with the mean result derived from Venus, the Earth, Jupiter, and Saturn, we must suppose the original planet to have revolved upon its axis once in 91 hours. Mr. Walker by assuming a mean distance of 2·9 (which I think inadmissible) and a double mass, has obtained a period of 58 hours. Is this an allowable supposition? I infer not, for the following reasons:

1. Schröter inferred from his observations that the planet Juno revolved upon its axis once in 27 hours.

2. From the analogy of the other planets which I shall consider on the next page.

III. The value of C computed for the planet Mars does not harmonize well with Kirkwood's law.

Mr. Walker has computed (Am. Jour., vol. x, p. 22) that if we assume the mass of Mars to be $\frac{1}{2\,7\,6\,\frac{1}{7}\,4\,6\,4}$, and employ his elements of the asteroids, Kirkwood's law will be satisfied. So large a mass for Mars appears to me inadmissible. Delambre long ago computed the mass of Mars to be $\frac{1}{2\,3\,4\,\frac{1}{6}\,3\,3\,3}$, (Mec. Cel., vol. iii, p. 334). Burckhardt in the Connaissance des Tems for 1816, diminished this by one twentieth, making it equal to $\frac{1}{3\,0\,8\,0\,\frac{1}{3}\,3\,7}$, and this is the mass now generally adopted. To increase it without any authority by more than *one fifth* of its value, seems altogether inadmissible.

IV. The values of C computed for Jupiter and Saturn do not harmonize as well as ought to be expected if Kirkwood's law is indeed a law of nature; but upon this I will not insist, as the computed sphere of attraction of Jupiter depends upon the mass and distance of the next interior planet, with regard to which there is considerable uncertainty.

I will now proceed to examine some of the analogies already alluded to, as existing between the planets of our system. We shall find that the planets are naturally divided into two classes, each distinguished by peculiar characteristics. This will appear from the following table, in which, column second exhibits the true diameter of each of the planets, and column third their density, (the earth being taken as unity;) column fourth shows the time of rotation upon their axes, and column fifth the compression of each planet as far as it has been determined.

	True diameter.	Density.	Rotation.	Compression.
Mercury, ...	0·398	1·225	$24^h{\cdot}1$	
Venus, ...	0·975	0·908	23 ·3	
Earth, ...	1·000	1·000	24 ·0	$\frac{1}{289}$
Mars, ...	0·517	0·972	24 ·6	$\frac{1}{168}$
Asteroids, ...				
Jupiter, ...	10·860	0·227	9 ·9	$\frac{1}{15\cdot7}$
Saturn, ...	9·982	0·131	10 ·5	$\frac{1}{10}$
Uranus, ...	4·332	0·167		$\frac{1}{10}$
Neptune, ...	4·741	0·230		

It is obvious at a glance that the first four planets in this table exhibit a strong family likeness, and the last four constitute a second family. Thus the diameters of the first class range between four and ten; the diameters of the second class range from forty-three to one hundred and eight. The average diameter of the second class is *ten times* that of the first class; while in each class, the smallest planet is four tenths of the greatest. Also the densities of the first class range from 0·9 to 1·2; those of the second class range from 0·13 to 0·23. The average density of the first class is *five times* that of the second; while the individuals of each class do not differ greatly among themselves.

The average time of rotation of the first class is *two and a half* times that of the second class; while the velocity of rotation for the several individuals of each class is almost identical.

The compression of the planets of the first class is small and difficult to measure. If the compression of Venus was the same as that of the earth, it would make but one-thirtieth of a second difference between its polar and equatorial diameters when in superior conjunction, a quantity too small to be sensible in micrometric measurements. The compression of Mars has been vari-

ously estimated. Sir William Herschel states that the polar diameter is about $\frac{1}{16}$ less than the equatorial diameter; but according to Arago, the two diameters are in the ratio of 189 to 194 which gives a compression of $\frac{1}{9}\frac{1}{7}$. Even this compression appears irreconcilable with the supposition that the figure of the planet is the figure of equilibrium of a fluid body.

The compression of the planets of the second class varies from $\frac{1}{14}$ to $\frac{1}{16}$.

The compression of a planet depends not merely upon its velocity of rotation, but upon the ratio of its centrifugal force to the gravity of the planet, and upon the law of density from the surface to its center. The centrifugal force can be computed when we know the time of rotation, but the law of density in the interior of the planet we have no direct means of determining.

Here then we find two classes of bodies with characteristics plainly marked; and if we suppose the asteroids to have been once united in a single body, probably no one would hesitate to assign it to the first of these classes.

These coincidences are so striking that we seem irresistibly led to the conclusion that the time of rotation of Uranus upon its axis cannot much exceed that of Jupiter or Saturn; and it is improbable that the period of the asteroid planet could much exceed twenty-four hours.

I cannot therefore agree with Mr. Walker in his conclusion that "whether Kirkwood's analogy is or is not the expression of a physical law, it is at least that of a physical *fact* in the mechanism of the universe." Even if future discoveries should prove it to be a *fact*, the law seems irreconcilable with what we must at present regard as the most probable values of the planetary elements. It is however much to be desired that the periods of rotation of each of the planets, particularly that of Uranus, should be determined with all possible precision, in order that any uncertainty which now rests upon this subject may be entirely dissipated.

ART. XXVI.—*On a new Genus of Crustacea in the Collections of the U. S. Exploring Expedition under Capt. C. Wilkes, U. S. N.;* by JAMES D. DANA.

THE genus Trapezia, as instituted by Latreille and accepted by authors, embraces two distinct genera, which are similar in the general form and appearance of the species, but are readily distinguished by several characters. The *Trapezia cymodoce* is the type of the true Trapeziæ, the *T. digitalis* or *glaberrima*

of the other genus. The following are their characteristics, omitting the points in which they agree.

Genus Trapezia.

Frons sinuosus vel 6–8-dentatus.

Maxillipedes externi marginem posticum fere transversi; apices que articulorum secundorum inter sese valde remoti.

Superficies prælabialis viaque efferens lineâ elevatâ divisæ margoque buccalis anticus utrinque emarginatus, emarginatione viæ efferentis ostio.

Pedes antici elongati, brachio extra carapacem valde exserto, margine brachii antico denticulato et apicem anticum acuto, manu fere rectâ, pollice parce deflexo.

Pedes 8 *postici* non unguiculati, tarso apicem pusillè producto et truncato.

Abdomen maris sæpius 5-articulatum.

Genus Tetralia.

Frons rectus aut rectiusculus, subtilissimè denticulatus.

Maxillipedes externi marginem posticum valde obliqui, apices articulorum secundorum inter sese paulo remoti.

Superficies prælabialis viaque efferens lineâ paulo elevatâ divisæ sed margo buccalis anticus vix emarginatus.

Pedes antici breviores, brachio apicem paulo exserto, margine brachii antico apicem rotundato subtiliterque denticulato, pollice valde deflexo.

Pedes 8 *postici*, breviter unguiculati.

Abdomen maris 7-articulatum.

The name *Tetralia*, from the Greek τετρα *four*, alludes to the subquadrate form of the species. The *Grapsilla* of M'Leay, as shown by Krauss and others is identical with Trapezia. The want of a proper claw to the tarsus in the Trapeziæ is a striking character, and is an anomaly among the Cancrinea. The extremity appears truncate in a side view as well as in an upper, and has nothing of the texture of a claw except in its minute points or setæ; while in Tetralia the tarsus is pointed in a side view though somewhat truncate as seen vertically; and the texture of the extremity is horny like a regular claw, which same texture extends back on either side.

In the closed orbits, the antennæ being wholly excluded, and in the ridge separating the efferent canal from the prælabial space as well as the narrow form, these genera are related to Eriphia. Fuller descriptions with many illustrations will be given in the Author's Report on the Crustacea of the Expedition, now ready for the press.

Art. XXVII.—*Mineralogical Notices.* No. II.*

On the Hardness of Minerals; by R. Franz, (Pogg. Ann., lxxx, 37.)—This very important memoir relates to the comparative hardness of crystals on different surfaces, and in different directions on the same surface, and contains the results of numerous careful observations.

Dopplerite, a new species.—This mineral, of vegetable origin, occurs in Styria near Aussee, in peat. According to Doppler, (Wien Acad. Ber., Nov. Dec., 1849, 239,) and Haidinger, (ibid, 287,) it is when fresh, brownish black with a dull brown streak and greasy subvitreous lustre, and also in thin plates which are reddish brown by transmitted light. G = 1·089, according to Fötterle. On exposure to the light, the substance becomes very elastic like caoutchouc. Heated to 100° C., when it loses 78·5 p. c. of water, it resembles a black pitch; on heating the fresh mineral with potash, ammonia is given off. Analysis afforded Schrötter, (Wien Acad. Ber., 1849, 285,)

C 51·63 H 5·34 O 43·03

giving the empirical formula $C^8H^5O^5$. Schrötter considers it an unusually pure and homogeneous peaty substance from whose cellulose 2 parts of water are removed—$C^8H^7O^7$ losing 2HO becomes $C^8H^5O^5$, the formula above.

Magnesite.—Breithaupt (Pogg., lxxx, 313,) found the angle of a magnesite from Snarum, Norway, 107° 28½′. Scheerer obtained for the mineral on analysis—

	Ċ	Ṁg	Ḟe	Ḣ
1.	51·447	47·296	0·786	0·470
2.	52·768	47·232	*undetermined*	

The formula from the first analysis is Ṁg Ċ.

Nemalite of Hoboken, New Jersey.—Analysis by Rammelsberg, (Pogg. Ann., lxxx, 284,)

	Ṁg	Ḟe	Ḣ	S̈i
	64·86	4·05	29·48	0·27=98·65
Oxygen,	25·49	0·90	26·20	

This result, giving for the formula of Brucite, Ṁg Ḣ, confirms the recent analyses of Whitney, (J. Bost. Nat. Hist., 1849, p. 36,) and Wurtz, (Dana's Min., 3d. edit., p. 682.)

Chlorite.—Delesse obtained (Ann. d. Mines, [4], xvi, 520) for a dull bluish green chlorite of feathery texture, from the Mandelstein porphyry of Oberstein, and of Planitz near Zwickau, the following composition:—

	S̈i	Ä̇l	F̈e	Ḟe	Ċu	Ṁg	Ḣ
1. Oberstein,	29·08	42·00		——	3·70	12·23	12.99=100·00
2. Planitz,	29·45	18·25	8·17	15·12	0·45	15·32	12·57= 99·33

* For Notices, No. I, see preceding volume, p. 245.

In the first of these analyses the magnesia was estimated from the loss.

[The second analysis gives for the oxygen ratio of the protoxyds, peroxyds, silica and water, 9·51 : 10·98 : 15·30 : 11·17 = 8 : 9 : 12 : 9.]

Byssolite.—Kengott (Min. Unters., i, 77,) has measured the capillary crystals of byssolite from the Tyrol, and obtained the prismatic angle 124° 21′, which is that of Hornblende.

Ægirine.—The Ægirine analyzed by Plantamour is a Hornblende. Another mineral so called from the Island Skaadön, near Brevig, Norway, proves on analysis by Plattner (Pogg., lxxx, 315,) to be a pyroxene. According to Breithaupt it is black or greenish black to leek green, (the latter when in small crystals,) with a greenish-gray streak; cleavage brachydiagonal, perfect, macrodiagonal distinct; parallel to M only in traces. G = 3·432—3·504. Calculation from a measured angle gives for M : M 86° 52′, the angle of pyroxene.

Breislakite.—The identity of Breislakite and Augite, has been proved by Prof. E. J. Chapman (Phil. Mag., xxxvii, 444, Dec., 1850) from a measurement of minute crystals detected by him in the Vesuvian specimens. They gave for P on the axis 106° 18′, M : M = 87° 10′.

Staurotide.—Crystals of Staurotide from Cheronice have afforded Kenngott (Min. Unters., i, 49) the following angles:—M : M (∞P) = 128° 57′; P(0P) : a ($\bar{P}\infty$) = 125° 36′; M : a = 137° 18′; M : *e* ($\infty\bar{P}\infty$) = 115° 39′. The last angle would give for M : M the angle 128° 42′, and for the vertical and horizontal axes the relation 0·676 : 1 : 0·480.

Chiastolite.—A rhombic prism of chiastolite of a peach blossom color, affording the angle 93° 30′ and specific gravity 3·10, gave E. Renou (Expl. Sci. de l'Algérie, Paris, 1848, 58, and Lieb. and K. Jahresb., 1849, 736) the following composition:

$\ddot{S}i$ 36·6 $\dot{A}l$ 61·9

with a trace of magnesia and iron, which is the composition of Kyanite. It is from mica slate in the vicinity of Bona.

Garnet.—A columbine-red garnet from Albernreit near Waldsassen in Bavaria, afforded A. Besnard (Correspondenzbl. Regensburg, 1849, iii, 30, Lieb. and K. Jahresb., 1849, 745)—

$\ddot{S}i$	$\dot{A}l$	$\dot{F}e$	$\dot{M}n$	Mg
38·76	21·00	32·05	6·43	3·95=102·19;—G=4·2

Feldspar of the porphyry of Lessines and Quenast, Belgium: by A. Delesse, (Bull. Soc. Geol. de France, [2], vii, 310.)—The feldspar is in macled crystals belonging to the triclinic system; they are finely striated, of a white color or slightly greenish, with

a vitreous lustre. The greenish crystals are less hard and probably have undergone some alteration by infiltration. The mineral from Quenast afforded

S̈i	Ä̈l	F̈e	M̈n	Ṁg	Ċa	Ṅa	K̇	
63·70	22·64	0·53	*trace*	1·20	1·44	6·15	2·81,	ign. 1·22=99·69

Delesse thence concludes that the feldspar is an oligoclase. The feldspathic paste of the porphyry contains some more oxyd of iron and magnesia than the crystals of feldspar, and Delesse distinguished minute crystalline plates disseminated through it, which appeared to be chlorite. The chlorite becomes of a bronze color after calcination.

The rock of Lessines affords crystals of axinite and epidote, besides quartz in crystals, and calcite. The porphyry taken as a whole afforded on analysis

S̈i	Ä̈l, F̈e	Ċa	Ṁg, alkalies,	Ḣ and C̈
57·60	25·00	3·23	9·92	4·25=100.

The proportion of silica is hence small, much below that of the oligoclase above described.

Analysis of Wollastonite from Auerbach, by F. L. Winckler, (Jahresb. f. pr. Pharm., xviii, 317,)

S̈i	Ċa and trace of Ṁg C̈	Ḣ	F̈e, M̈n
53·0	45·40	1·0	0·6

On the Variolite of La Durance; by M. Delesse, (Ann. des Mines, 1850, [4], xvii, 116.)—The variolite consists of globules ordinarily of a whitish or greenish color, thickly imbedded in a green paste, and sometimes so densely aggregated as to exclude the paste altogether. The globules vary in size from half an inch to a point almost microscopic, and in the wear of the rock stand out on its surface. They are often of a violet shade within and have usually a somewhat radiated structure, concentric without, though at times containing minute disseminated white tabular crystals. On exposure they become a brownish or whitish kaolin. The paste is occasionally clouded in color or spotted serpentine-like. The specific gravity of the rock according to Delesse is 2·896; according to Brisson 2·934. In a similar rock from near Briançon the globules have a more uniform texture, and are imbedded in a blackish green paste. They are without cleavage and have a flinty fracture, G=2·923; which is above that of any known feldspar. The composition of these globules was found by Delesse to be—

S̈i	Ä̈l	F̈e	C̈r	M̈n	Ċa	Ṁg	Ṅa	K̇	
56·12	17·40	7·79	0·51	*trace*	8·74	3·41	3·72	0·24,	ign. 1·93=99·86

They are properly therefore a feldspar, although it is difficult to determine certainly the species; as there is a euphotide in contact with the rock, Delesse suggests that it is probably the same with the feldspar of the Euphotide of Odern.*

* This Journal, [2] x, 252, and Ann. des Mines, [4], xvi, 323.

The green base, Delesse shows is not hornblende or diallage, but probably impure feldspar discolored by oxyd of iron and magnesia. The variolite of La Durance contains at times serpentine, and may be observed in some places graduating into this rock.

Variolite, euphotide and serpentine are usually associated in the same region. The mean composition of the rock from La Durance is

$\ddot{S}i$	$\ddot{A}l$	$\ddot{C}r$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	
52·79	11·76	*trace*	11·07	*trace*	5·90	9·01	3·07	1·16, ign. 4·38	=99·14

The rock is intersected by seams of epidote, quartz or carbonate of lime, and sometimes the globules are broken across by a vein and the two halves more or less displaced.

The glass formed from the variolite had the density 2·288, showing a great diminution from that of the unaltered rock, which is about 2·9.

This variolite receives a fine polish and is worked into ornaments of various kinds.

Orthite from East Bradford, Chester Co., Pennsylvania.—This mineral was sent by Mr. Thos. Seal, of Philadelphia, to Mr. J. D. Dana, and by the latter to Rammelsberg. Analysis afforded this chemist (Pogg. Ann., lxxx, 285)

	$\ddot{S}i$	$\ddot{A}l$	$\ddot{F}e$	$\dot{F}e$	$\dot{C}e$	$\dot{L}a$	$\dot{C}a$	$\dot{M}g$	
	31·86	16·87	3·58	12·26	21·27	2·40	10·15	1·67, ign. 1·11	=101·17
Oxygen,	16·55	7·88	1·07	2·72	3·15	0·35	2·88	0·65	

This gives the oxygen ratio for the protoxyds, peroxyds and silica 9·75 : 8·95 : 16·55, and the formula $\dot{R}^3\ddot{S}i+\ddot{R}\ddot{S}i$, which agrees with the recent analysis of orthite by Rammelsberg, making the mineral analogous in composition to garnet.

Rutile.—The following are analyses of rutile by A. Demoly (Thèse de chemie, presentée à la Faculté des Sciences de Besançon, and Lieb. and K. Jahresb., 1849, 728):—

	$\ddot{T}i$	$\ddot{F}e$	$\ddot{M}n$	$\ddot{S}i$
1.	96·41	1·63	0·13	1·83=100
2.	96·45	1·62	0·14	1·79=100
3.	96·43	1·62	0·11	1·84=100

Brookite.—N. von Kokscharov has recently investigated the crystallization of Brookite of the Ural and the following are a part of the results obtained (Pogg. Ann., lxxix, 454):—$\breve{M} : \breve{M} =$ 90° 50′ and 80° 10′. Angles of octahedron P, 101° 35′, 115° 43′, 111° 26′; of 2P, 87° 12′, 104° 54′, 142° 21′; of $\breve{P}2$, 135° 37′, 101° 3′, 95° 22½′; of horizontal prism, $2\breve{P}\infty$, 55° 48′ and 124° 12′; $\frac{4}{3}\breve{P}\infty$, 76° 55′ and 104° 5′; $\frac{1}{4}\breve{P}\infty$, 148° 39½′, 31° 20½′; $\frac{1}{2}\breve{P}\infty$, 121° 24½′, 58° 35½′; of vertical prism, $\infty\breve{P}2$, 45° 38½′, 134° 21½′. Specific gravity of the crystals according to Mr. Frödmann, 4·22.

On the Identity of Arkansite of Shepard and Brookite; by R. Hermann, (J. f. pr. Chem. l, 200.)—The identity of Arkansite with Brookite has been shown independently by J. D. Whitney, Miller, Rammelsberg, Breithaupt and Descloiseaux. Hermann confirms the previous measurement, obtaining the prismatic angle 100° 30′, and the octahedral angles 135° 30′, 101°, and 94°. His analysis afforded titanic acid 96·50, peroxyd of iron 1·00, protoxyd of uranium *a trace*, silica and gangue 2·50 = 100·00. Specific gravity = 3·79.

On Pyrochlore; R. Hermann, (J. f. pr. Chem. l, 185.)—The Brevig Pyrochlore analyzed by Wöhler is called Hydrochlore by Hermann, on account of its affording 7·06 per cent. of water. He applies the same name also to the Fredericksvärn crystals which gave Wöhler 4·20 per cent. of water, (with 62·75 metallic acids, oxyd of tin 0·61, peroxyd of cerium 6·80, protoxyd of uranium 5·18, Fe 2·16, Mn 2·70, Ca 12·85, alkalies *trace*.) [Adopting this plan of naming varieties containing water, without first ascertaining by extensive investigation that the water is essential to the original mineral, there will be no end to the new names to be coined.]

Another pyrochlore from Miask analyzed by Wöhler, he calls Fluochlore on account of its containing some fluorine. Hermann has analyzed the Miask pyrochlore and gives his former results anew as follows:

Niobic and ilmenic acids 62·25, titanic acid 2·23, zirconia 5·57, Ce 3·09, La 2·00, Y 0·70, Fe 5·11, Mn *trace*, Ca 13·54, K, Na, Li, 3·72, F 3·00, H 0·50 = 101·71. G. = 4·203.

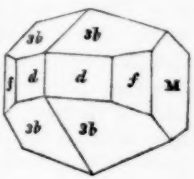
According to a more recent analysis by him it contains

Niobic acid 60·83, Titanic acid 4·90, Ce and La 15·23, Y 0·94, Fe 2·23, Ca 9·80, Mg 1·46, K 0·54, Na 2·69, F 2·21 = 100·83.

[It is well known that fluorine enters into the constitution of certain micas and other minerals, in some of their varieties, and yet is not essential to the species. There is therefore no propriety in assuming in the above case that the fluorine variety of pyrochlore is a distinct species or is worthy of a distinct name.]

Mengite; Hermann, (J. f. pr. Chem. l, 179.)—Breithaupt remarks that the angle of the prism of Mengite (*d*) 136° 40′, is identical with a prism of columbite. Another prism (*f*) gives 100° 28′, and the rhombic octahedron (3*b*) has the angles 150° 32′, 101° 10′, 86° 21′. According to Rose it is a zirconia mineral, and it is therefore an example of isomorphism.

1.



On Yttroilmenite and Samarskite; by R. Hermann, (J. f. pr. Chem. l, 164, No. 11, 1850.)—Hermann still sustains his view that yttroilmenite contains the acid of a new metal *ilmenium*, con-

trary to the investigations of Rose. In an analysis of Samarskite he obtained

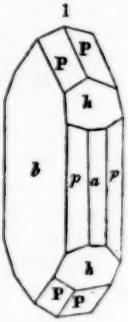
Niobic acid with a little ilmenic 56·36, $\dot{U}$ 16·63, $\dot{M}g$ 0·50, $\dot{M}n$ 1·20, $\dot{F}e$ 8·87, $\dot{Y}$ 13·29, $\dot{C}e$, $\dot{L}a$ 2·85=100·03.

According to which it is a niobate of protoxyd bases. Color of specimen black, with partly a grayish-brown crust. G.=5·64.

On Æschynite; by R. Hermann, (J. f. pr. Chem. l, 193.)—Hermann has reänalyzed Æschynite and found it to consist of

Niobic acid, 33·20, titanic acid 25·90, $\dot{C}e$ 22·20, $\dot{C}e$ 5·12, $\dot{L}a$ 6·22, $\dot{Y}$ 1·28, $\dot{F}e$ 5·45, $\dot{H}$ 1·20=100·57.

Polycrase and Polymignite, (Hermann, J. f. pr. Chem., l, 181.)—The angles of polycrase are as follows, according to Scheerer and Hausmann's calculations: octahedron P, 152° 0′, 90° 2′, 96° 41′; vertical prism (*p*) 140°; brachydiagonal prism (*h*) 56° 0′. Hermann observes that if the crystals be viewed in a different position, the angles approach those of columbite, in which P=150° 17′, 86° 52′, 100° 49′; brachydiagonal prism (corresponding to vertical above) 123° 50′ to 125° 20′; macrodiagonal prism (corresponding to brachydiagonal above) 139° 6′. Although the composition is widely different from that of columbite, the two minerals are approximately isomorphous.



Polymignite is related crystallographically in the same manner to columbite. The three prisms of 70° 50′, 109° 10′ and 140° 51′ in Polymignite, correspond to three prisms 70° 50′, 109° 35′, 141° 8′, in columbite. To perceive the relations between the crystals of the two minerals, the vertical prisms of polymignite, as the mineral is usually drawn, should be compared with a series of horizontal prisms in columbite.

Hermann also remarks that Brookite approaches columbite in its angles.

Hermann adopts the view that tantalic and the related acids contain 2 of oxygen like titanic acid; and he concludes also from the isomorphisms observed, that zirconia is a protoxyd, urging that it does not replace alumina while it does replace protoxyds. Mengite he makes a titanate of protoxyd of iron and zirconia; polymignite a titanate of the same with yttria; polycrase a titanate and tantalate of protoxyds of zirconium, iron, uranium, cerium; yttroilmenite an ilmenate and titanate of protoxyds of yttrium, iron and uranium; columbite a niobate, pelopate or ilmenate of protoxyds of iron and manganese (3 of acid to 2 of base.) He also concludes that Wolframic acid has the formula $\ddot{W}$ and not $\dddot{W}$, on the ground that Wolfram ($\dot{R}\,\ddot{W}$) is isomorphous with columbite. [This last case of isomorphism ap-

pear to be set aside by Descloiseaux's measurements which make Wolfram *oblique* in crystallization.]

Red Antimony.—Kenngott has examined crystals of this mineral from Bräunsdorf, (Min. Untersuch., i, 1, Breslau, 1849, and Liebig and Kopp's Jahresb., 1849, 727,) and obtained for the inclination of the vertical axis to the terminal plane (0P) 77° 51′; $0P : \infty P\infty = 102° 9'$; $0P : P\infty = 149° 46'$; two planes ($P\infty$, and $\frac{1}{3}P\infty$) incline to the vertical axis at angles of 37° 37′, and 71° 55′.

Titaniferous iron.—Vast deposits of titaniferous iron have been found by Mr. T. S. Hunt about the bay of St. Paul, Canada. One mass is 90 feet in breadth and 300 long. The masses are imbedded in a syenitic rock. The ore is massive and often coarsely granular. Color and streak black. G. = 4·56—4·66. H. = 6. Feebly affects the magnetic needle. Analysis gave

Oxyd of Titanium 48·60, Protoxyd of Iron 46·44, Magnesia 3·60=98·64.

The iron was principally in the state of protoxyd, but a portion was in the state of peroxyd and to this the deficiency in the analysis is attributed.—*Logan's Rep. Geol. Canada*, 1850.

Triphyline.—The Triphyline of Bodenmais has been analyzed by Baer (Arch. Pharm. [2], lvii, 274, and Lieb. and K. Jahresb., 1849, 773) with the following result:

$\dot{R}\dot{P}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{L}i$	$\ddot{S}i$
36·36	44·52	5·76	1·00	0·73	1·19	5·16	5·09	1·78=100·59

Supposing the silica in combination with part of the protoxyds as $\dot{R}^2\ddot{S}i$, the analysis affords the ordinary formula of the species $\dot{R}^2\dot{P}$. After heating, the mineral dissolves in acids and becomes brownish red.

Humboldtine or Oxalate of Iron.—This species has been detected by Mr. T. S. Hunt at Cape Ipperwash, Canada, in shales; it occurs as a soft earthy coating or incrustation of a sulphur yellow color. On heating, it instantly blackens, becoming magnetic, and then changes to red. The shales contain species of calamites, which tends to confirm the opinion that its formation is of vegetable origin.—*Logan's Rep. Geol. Canada*, 1850.

On Beudantite; by John Percy, M. D., (L. E. and D. Phil. Mag., [3], Sept., 1850, xxxvii, 162.)—Dr. Percy confirms the conclusion of Damour and Descloiseaux, (Ann. Ch. Phys., [3], x, 73,) that Beudantite is Cube ore, although quite impure. In his analyses he obtained

	$\ddot{S}$	$\dot{A}s$	$\dot{P}$	$\dot{F}e$	$\dot{P}b$	$\dot{H}$
1.	12·31	9·68	1·46	42·46	24·47	8·49=98·87
2.	12·35	13·60	*undetermined*	37·65	29·52	8·49=101·61

Owing to the small quantity under investigation Dr. Percy observes that these results can be considered as only approximate. The determination of the arsenic acid in the second analysis is

probably somewhat in excess. He infers that the mineral is cube ore (or arsenate of peroxyd of iron) containing as impurities sulphate of lead and sulphate of iron.

Copper-Mica of Andreasberg.—Rammelsberg (Pogg. Ann., lxxix, 465) has examined this mineral, before investigated from a different locality (Ockerhutte) by Beneke (Pogg. Ann., xli, 333) and Borchers, (ib., p. 335,) and first mentioned by Hausmann and Stromeyer, (Schw. J., xix, 241,) and has confirmed the analysis of Borchers. It occurs mixed with black copper in gold-yellow mica-like scales, which separate on subjecting the mass to dilute nitric acid. The results of Rammelsberg and Borchers are—

	O	Cu	Ni	Sb
1. Rammelsberg,	18·31	34·63	23·00	22·40=98·34
2. Borchers,	18·67	35·16	23·97	21·06=98·86

or

Ċu	Ṅi	S̈b
43·38	29·23	26·57
44·28	30·61	25·11

giving the formula Ṙ¹² S̈b. Specific gravity 5·783.

Black oxyd of Copper of Lake Superior.—Rammelsberg states (Pogg., lxxx, 287) that this ore afforded Mr. Joy, of Boston, in his laboratory, in a pure specimen, 99·45 per cent. of oxyd of copper; another specimen gave besides oxyd of copper—

1·19 F̈e, 0·23 Ċa, 3·38 S̈i.

Chalcotrichite (*Kupferblüthe*).—Kenngott (Min. Unters., p. 31, and Lieb. and K., p. 727) describes crystals of chalcotrichite or the capillary red copper, both from Nischne-Tagil and Rheinbreitenbach, which pertain to the trimetric system. They occur in rhombic prisms of 140 to 150 degrees with the edges truncated. This oxyd of copper appears therefore to be trimorphous.

Tin Ore and Gold from Wicklow.—The tin ore occurs with gold at the stream-works in the county of Wicklow. W. Mallet obtained on analysis (Trans. Geol. Soc., Dublin, and Phil. Mag., xxxvii, 392) Peroxyd of tin 95·26, peroxyd of iron 2·41, silica 0·84=98·51. Platinum is reported from the same region, besides sapphire, topaz, zircon, molybdenite, wolfram, pyrites and other iron ores, &c.

The gold afforded Mr. Mallet, Gold 92·32, silver 6·17, iron 0·78= 99·27, equivalent to 8¼ atoms of gold to 1 of silver. Sp. gr. =16·342.

Irite.—Crystals of Irite in regular octahedrons have been observed by Kenngott (Min. Unters., i, 61).—They are much flattened parallel to one of the faces. The true formula of the species is probably included under Ṙ R̈, which embraces the spinels, magnetic iron and some other tesseral species.

Note.—Errata in the writer's Mineralogy, third edition.—p. 45, 9th l. from bottom, for *m' n' P* read *m' P n'*.—p. 209, Arragonite, anal., for F̈e Ḧ read F̈e³ Ḧ³.—p. 211,

NOTE.—We add here the following notice communicated for this Journal :—

On the Vanadium Minerals from Lake Superior; by JAMES E. TESCHEMACHER.—The surface of the large masses of copper found in the celebrated Cliff mine, on the border of the lake, is sometimes encrusted with thin layers of small crystals of quartz, interspersed with a yellow pulverulent substance resembling peroxyd of iron. On exposing small pieces of these layers to the action of the blowpipe, this yellow powder turns black. Pulverized with the quartz and boiled in dilute nitric acid gives a very light apple-green solution; this powder so treated, washed, filtered and evaporated to about the amount of the water used in washing, was left untouched for about a month, when minute crystalline red globules began to form on the surface, which fell to the bottom, when by aggregation they became sufficiently heavy. The form of these crystals could not be determined even by the microscope, the crystalline points were so numerous and in such apparent confusion. From these red crystalline masses, the writer, as well as Dr. A. A. Hayes, produced the vanadiates of silver and lead. No metal having been found in the solution, it is probable that the yellow powder exists here as vanadic acid, VO^3.

The chocolate-colored earth from Isle Royale is quite a different mineral. After a few preliminary trials, the following process was adopted. The pulverized mineral was digested a short time in dilute nitric acid; from this a light blue solution was obtained, showing the separation of a small quantity of copper, although great care had been taken in the separation of the mineral from the mass of copper it invested. After washing with a small quantity of hot water and drying, the deeper red colored powder was boiled in dilute hydrochloric acid, washed with a small quantity of hot water and dried. The result of this separation of a considerable proportion of iron was a very light grey-

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anal. 16, before 2·25 add Ḟe, and for No. 21, 22, 23, before the analyses, read 22, 23, 24.—p. 213, Hydromagnesite, anal. 1, for 0·27, read 0·57, and for 1·66 read 0·27. —p. 226, 21 and 27 l. from top, for Ṁn, read M̈n.—p. 250, anal. 7, for 19·342, read 18·342.—p. 252, anal. 6, for 4·83, read 3·83—p. 293, anal. 8, 9, 10, for Ḟe, read F̈e.—p. 294, anal. 11, 12, 13, for M̈n, read Ṁn.—p. 299, last line, dele "laumonite (Damour's) and."—p. 303, anal. 2, for 33·70, read 22·70.—p. 309, anal. 20 is by Mr. Anderson.—p. 310, anal. 1, Haydenite, for 0·27, 0·25, read 2·70, 2·50.—p. 316, anal. 11, for 56·111, read 54·111.—p. 339, 20 l. from top, for Mexico, read Sterling, Mass. —p. 353, 16 l. from top, for 22, read 23, and anal. 27, for 13·25, read 18·25.—p. 361, anal. 3, for 3·15, read 4·15.—p. 362, anal. 3, for 51·50, read 51·20; anal. 5, for 0·92, read 0·72, and for 100, read 100·46; anal. 6, for 100, read 100·10; 7th line from bottom, for 3Ḧ read 9Ḧ.—p. 366, anal. 5, 6, 7, for H F, read F.—p. 367, anal. 8, for H F, read F.—p. 371, anal. 6, add S̈i 5·59.—p. 381, Thorite, for Ż̈n, read S̈n.—p. 382, anal. 11, for B̈e 4·50, read Be 3·50.—p. 395, Æschynite, anal. 2, 3, for C̈e, read Ċe.—p. 401, anal. 3, for 69·62, read 79·62; anal. 9, for 0·2, read 2·0.—p. 679, Tritomite, anal. for C̈r, Ḟe, Ca, read C̈e, L̈a, Cu.—p. 689, last line, dele 3 before Ṙ S̈i.—p. 694 Rensselaerite, anal. 1 and 2, add, Ṁg 32·90, Ṁg 25·20. J. D. D.

colored powder. This was heated to redness in a silver crucible with caustic potash; prior to red heat combination took place with some violence, and on boiling with water a grey flocculent precipitate went rather rapidly to the lower part of the filter, which was washed with a little boiling water. This precipitate on drying changed to a dark-grey color. Before the blowpipe with borax, in the reducing flame, this gave a clear globule, yellow while hot, fine green while cold, producing these changes as often as desired. A small portion boiled in nitric acid, dried and exposed to the blowpipe alone on the platina wire, fused into brick-red globules, but on urging the reduction flame, after a little time these globules fused together with a brilliant light and left a grey porous mass. These actions before the blowpipe are characteristic of vanadium. If only a minute quantity of the grey powder is used, the bead is yellow while hot, but the green color is scarcely visible.

After separating the grey powder, hydrochloric acid was added to the filtered liquor in excess. Evaporated to dryness, silica was separated; but previous to drying there appeared a small quantity of grey powder, which, after twenty-four hours' exposure in water to the air, changed to a distinct green color. This is probably the silicate of vanadic oxyd, and it passed in solution through the filter; it is almost impossible to separate it from the silica, which was again fused for a considerable time with the caustic potash and separated by hydrochloric acid. The silica was now mixed with a number of colored grains, which, under the microscope, varied from a transparent red to a dark black, and were probably VO^2 and VO^3, combined with the silica. From the washing a small portion of alumina was afterwards separated by ammonia. From the absence of all metals except iron and the minute quantity of copper before mentioned, it is probable that the mineral here is in the state of vanadic oxyd VO^2. I regret that my stock of this interesting mineral is so nearly exhausted as to preclude any farther investigation, but as it must exist there in abundance, and the vanadic oxyd seems to me to amount to at least 20 per cent., I trust we shall not be long without more knowledge on this subject. On igniting the vanadiate of ammonia from the first mineral in a platina capsule, a combination with the platina took place, forming a dark bluish-black stain which could only be removed by scraping; this made me cautious in using platina vessels. The combination with silica would probably render the process in question useless for quantitative analysis.

ART. XXVIII.—*Notices of Coal in China;* by D. J. MACGOWAN, M. D., Cor. Mem. of the Asiatic Society of Bengal.*

COAL deposits exist to a greater or less extent throughout the different mountain ranges which girt the great plain of China. On its northern boundary this mineral is met with in numerous localities, on the Celestial Mountains, on the Mongolian steppes, and various offsets of the Altai range, the most productive of which are in Shingking and Shánsí. There are several smaller deposits in Chihlí and Corea. Unskillful mining, and the want of suitable means of transport, enhance the cost of the mineral, and limit its consumption. Except for culinary and manufacturing purposes, it is little used, the inhabitants trusting to furs and skins for protection from the extreme rigor of their winters.

The best coal brought to the capital, is from Pingting chau in Shánsí. Anthracite of good quality is brought from Káichau in Liáutung. Chinese cosmogonists, drawing on mythology, gravely state, that in one of the Pingting mines the furnace still exists, in which Niúkwa fused stones for repairing holes in the heavens, and that it is the original of furnaces now in use. Those deposits which have been mined for the longest period, with which we are best acquainted and are the most productive, lie in the middle and southern parts of the empire.

That branch of the Himalayan range, known as the Yun-ling, forming the prominent topographical feature of the provinces of Sz'chuen, Yunnán, Kweichau, Húnan, Kwángtung, Fuhkien, Kiángsi, and Chehkiáng, has the carboniferous system superimposed on a granitic base through a great part of its extent, in numerous sections of which the coal measures exist, generally interstratified with beds of slaty clay and limestone. Those best known lie in the basin of the Kán in Kiángsí, reposing on old red sandstone and gray compact limestone, in close connection with deposits of iron ore. Those in the valleys of the Siáng, Tsz', and Yuen in Húnán, the west slope of the terminal ridges of the Yun-ling in Chehkiáng, at the sources of the Tsientáng, and the southern aspect of the same range in Kwángtung at Nánhiung, all present analogous geological relations. This vast carboniferous tract appears to be continuous in a measure with that of Assam and Burmah.

The coal most in demand in central China is called "the Kwang coal." It is brought from various districts in Húnán. Súchau is the entrepôt for all that is consumed in Kiángsú and Chehkiáng. It is black, very compact, specific gravity 1·34, columnar structure occasionally iridescent, and from the large quantity of carbon

* Chinese Repository, vol. xix, July, p. 385, 1850, No. 7.

it contains is analogous, though inferior to the American anthracite; it burns intensely with a small blue flame, its ashy residuum being of a reddish color. That in use at Shánghái is of this description. It is brought from Súchau, via Chapú to Ningpo, where it costs $12 per ton, about one third more (the dealers say) than at Shánghái. Its consumption is very limited, being almost wholly confined to the manufacture of brass tobacco pipes. The best quality of this coal, that which most resembles anthracite, is well adapted for grates and stoves, being free from fumes of sulphuretted hydrogen, and is more wholesome than the bituminous coal usually imported from Liverpool and Sydney.

Numerous varieties are produced in the province of Kiángsú, slaty, cannel, bituminous and anthracite. Portions of the latter are sold at Súchau as the *kwáng* coal. A considerable quantity from the mines in Kwángsin is carried over the mountains into the province of Chehkiáng. It is found abundant also in Fungching and Chingkiáng. The proximity of the coal measures in this province to ferruginous ore and lime, facilitates the manufacture of iron. Some of the mountains which support the subterranean treasures, afford disintegrated granite, of which the celebrated porcelain is fabricated. The furnaces in Kingteh-chin, the great seat of this branch of industry, are chiefly heated by coal procured from adjacent mines. The generic designation for the mineral produced from the Chehkiáng mines, is Kiángshán coal, the name of the district in Küchau fu, in the S. W. part of the province, whence it is chiefly derived. A large quantity however comes from the conterminous districts of Síngán, and Chángshán. The principal mines are at the Wúkwei mountain, near Kitung, and at the Chenkiá lake in the first named district. There are several varieties, that most valued is termed "wood coal;" it exhibits, where it is laminated with the fibres of the bituminated vegetable, a distinct, bright, conchoidal fracture; at all other points it presents a dull, coarse-grained, segregated texture. Specific gravity 1·29. It burns with some smoke, and cakes; emitting a small quantity of hydrogen gas, leaving light colored ashes. It possesses a much larger proportion of carbon than ordinary bituminous coal, and some specimens compare very favorably with that brought from England, and stored at Ningpo for H. B. M. steamers; yet generally speaking, the coal found on this continent is unfit for the steam engine, that from the island being better adapted for such purposes. One of the varieties is called *iron coal;* "it is slaty, and can be ignited only with the aid of the bellows; another is the *Barbarian coal*, which burns rapidly, with a large amount of smoke, and resembles brown coal. The peculiar properties of other varieties are designated by their names as "stinking coal," "crackling," and "smoky coal;"—an inferior quality comes from one of the mines, abounding in sulphuretted hydrogen, and closely resembles the coal found near Canton.

The "wood coal" is generally reduced to powder, and formed into cakes with mud, and employed in furnaces for culinary purposes, and in chafing dishes for warming public offices. It is used to some extent by blacksmiths. Coal cakes are much used at Hángchau, in the liquor shops, in order to keep warm rice-whiskey on hand at all hours of the day; and in the tea shops, where boiling water is in constant requisition. The furnaces are certainly primitive, consisting of a few bricks making a close square or circular chamber, generally about four inches in diameter with a small grate below, and inclosed above. When the cakes are perfectly ignited by a few chips, and the smoke ceases to rise, the top is covered with mud, through which, before drying, an orifice is pierced half an inch in diameter. The vessel containing whiskey is then placed over the hole, and is thus kept hot all day without further care, at a cost of a cent and a half. The same rude apparatus, with slight modifications, is in general use wherever coal from its proximity is not expensive. Sometimes the brickwork is inclosed in boards, elaborately carved and varnished. Were grates or fire-places constructed with suitable flues and chimneys, coal would be found a more useful article, be in great demand, and the mines consequently be better worked. Even the miners find it more convenient and cheaper to burn the shrubs and grass of their sterile hills than the coal they dig from their bowels.

Twenty thousand tons of coals are annually brought from these mines to Hángchau, which at the hills cost $5.75 per ton; the baskets in which the mineral is packed bring the cost up to $6.50; and the expense of transportation to Ningpo raises it above $8 per ton. The annual production and value of the Chehkiáng coal mines may be computed with considerable accuracy, and thus afford data for a national estimate, which may be thus given:

Chehkiáng, - - - - - - -	60,000 tons.
Kiángsi, - - - - - - -	160,000 "
Húnán, - - - - - - -	230,000 "
Northern Provinces, - - - -	280,000 "
Kwángtung and Western Provinces, -	100,000 "
Total, - - - - -	820,000 "

This portion of the mineral wealth of China may be computed at nearly six millions of dollars. The paucity of the supply is owing not to the poverty of the mines, but chiefly to the want of those facilities for mining, which the steam-engine alone can supply. Mines often, when they become most productive, are suddenly filled with water and rendered useless. In this manner an immense number of shafts of great extent are unavailable. Provided with the steam-engine and the safety lamp, the Chinese miner could doubtless bring to light inexhaustible supplies of this subterranean treasure.

Chinese miners are extremely poor and rude mountaineers; it is said they often relieve hunger by eating coal, and if it be true, as has been represented, that pigs fatten on this mineral in some western countries, this report respecting Chinese miners is not incredible. For the most part, the mines are worked in horizontal shafts, though pits are sometimes dug. At one period, powdered coal was mixed with flour and the juice of dates, and burned in chafing-dishes for producing a fragrant perfume. For such pastils, charcoal has been substituted. This mineral, the source of so much wealth and power in the West, does not appear to have been known to Europe more than three hundred years, but Chinese antiquarians refer its use to a remote period in their history. Its utility in the arts has been appreciated at Peking for more than a thousand years, as may be inferred from the encomiums bestowed upon it by a poet of the Sung dynasty, who lauds it as useful in the manufacture of iron implements. A writer in the early part of the seventh century mentions the article. The earliest notice of coal is in the history of the Hán dynasty, B. C. 202 to A. D. 25, where the remark occurs that Kiángsi produced stones, which were used as fuel.

To appreciate rightly the value of these vast coal deposits, extending from Corea to Siam, regard must be had to the increasing commerce of the Pacific, to the revolution which seems on the eve of taking place in the route of communication with western nations, and to the prospective greatness of the Anglo-Saxon states springing into existence on its eastern shores. Of their capacity, aided with the appliances of foreign skill and capital to supply all demands which the steam-engine may make upon them, both for manufactures and navigation, there can exist no doubt.

Nor have these primeval forests been stored upon the continent alone; they abound in more accessible situations, isolated, as it were expressly for steam navigation, in the islands of Japan, Formosa, and Borneo. Before the application of steam and coal to navigation, a skeptical philosophy might have questioned the utility of deposits of this mineral in the torrid zone, and immediately under the equator; but the design of the Omniscient Artificer of this beautiful sphere is now obvious, affording another evidence that He left nothing to fortuitous circumstances: it is another lesson fraught with instruction for reflective minds. May the name of the immense sheet of water, on whose shores Infinite Beneficence has scattered this mineral, indicate the peaceful purposes of all who traverse it, that both elements may contribute to the diffusion of commerce and civilization in fusing hostile races into a common brotherhood!

Ningpo, February 1st, 1850.

ART. XXIX.—*Abstract of a Meteorological Journal kept at Marietta, Ohio, for the year* 1850, Lat. 39° 25′, Long. 4° 28′ west of Washington; by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER.						BAROMETER.		
	Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Inches of rain and melted snow.	Winds.	Maximum.	Minimum.	Range.
January, - -	29·13	58	1	13	18	5·25	S. W. & S. E.	29·80	28·85	·95
February, -	34·33	64	2	12	16	3·41	S., S. W. & N.	29·90	28·50	1·40
March, - -	39·11	66	9	13	18	4·50	S. E., S. & N.	29·70	28·65	1·05
April, - -	48·11	80	22	16	14	3 17	N., S. & S. E.	29·70	28·65	1·05
May, - -	55·81	86	32	23	8	3·25	S. W. & N.	29·60	28·98	·62
June, - -	69·27	88	39	26	4	4·84	S. W. & N.	29·70	29·25	·45
July, - -	76·14	92	66	27	4	4·41	S. & S. E.	29·45	29·25	·20
August, - -	71·77	89	50	23	8	6·91	S. — N.	29·60	29·20	·40
September, -	63.33	84	40	26	4	4·66	S. — N.	29·64	29·10	·54
October, - -	51·48	81	27	22	9	2·54	S. W. & W.	29·60	29·10	·50
November, -	44·68	75	18	18	12	2·42	S. S. W. & S.	29·60	29·15	·45
December, -	34·66	65	10	14	17	7—	S. W. & W.	29·75	28·45	1·30
Mean for year,	51·48			233	132	52·36				

THE mean temperature for the year 1850 is 51°·48, which is somewhat less than that of 1849, being 52·09. This depression may be found in the low grade of the spring and autumn months; the mean for this year being nearly five degrees less in the spring than that of 1849, while autumn is about one degree below. The summer was warmer by about one degree and a half. The greatest heat was in July, the mean for that month being 76°·14, while July of 1849 was 72°·20.

The mean temperature of the winter was 31°·53, being almost three degrees less than the preceding one. It was not remarkable for any excesses in temperature, or depth of snow;—at various times, there fell during the winter seventeen inches; ten was the greatest fall at one time; it took place on the 13th of January, but soon melted away. The Muskingum river was frozen over on the first day of January, and remained closed for fifteen days. Ice was formed about three inches in thickness, affording a scanty supply for the ice houses. In the Ohio river there was much floating ice, but not so abundant as to stop the running of steamboats. The temperature was at no time below zero, but stood at one above on the first day of the year. There was a large quantity of rain in January, over five inches, and at one time the rivers threatened an overflow of their banks. February usually furnishes the coldest weather of any of the winter months, but this year the mean was five degrees above January. The mean of one day, the fourth of this month, was below that of any other, being only eight degrees, while the lowest in January was thirteen.

The mean of the spring months was 47°·68, which is nearly 5° below that of 1849. The cold backward weather of March and April, retarded the blossoms of fruit trees so much, as in a measure to guard them against late spring frosts, which in southern Ohio, is the greatest drawback to the fruit-grower. The consequence was a full and fine crop of fruits of all the usual varieties, and of the best quality. A severe drought the last of May and early part of June, at one time threatened the total destruction of the corn, oats and potatoes, it continuing nearly a month without rain. But a full supply the last of June, put all right again. This drought, however, was very favorable to the wheat crop, ripening it without rust; a disaster certain to befall it if the weather is wet and hot when the grain is in the milk or immature state.

The mean of the summer months was 72°·39, being nearly a degree and a half above that of the preceding year. This warm weather was exceedingly favorable to the ripening of fruits, especially melons, which were in great perfection; also to the growth of sweet potatoes, which have become an important crop, with some of our farmers, especially near the large towns. It also suited the grape, which is a valuable article of culture. A serious evil, however, has begun its ravages on this delicious fruit, namely, the grape Curculio, which threatens to be disastrous to its future prosperity. Two or three years ago, it was first noticed in this vicinity. I have several of its larvæ in a pot of earth, intending to study its economy and habits.

The temperature of autumn, was 53°·16; being more than a degree less than in 1849. Severe frosts did not appear, till the 29th October, when Dahlias were first killed.

Floral Calendar.—March 19th, First robin, heard; 21st, Black birds; 23d, Blue bird; 31st, Hepatica triloba in bloom—Early Hyacinth.

April 7th, Apricot in bloom; 21st, Service tree; 22d, Peach tree; 23d, Imperial gage and prune; 24th, Sanguinaria canadensis; 27th, Pear; 28th, Ranunculus virosa; 29th, Pyrus Japonica —very late this year, usually a week before the Pear tree; 30th, Cherry.

May 2d, Apple tree in bloom; 4th, Judas tree; 6th, Cornus Florida; 8th, Chickasaw plum; 11th, Tulips; 12th, Hickory tree; 16th, Quince; 19th, Lilac and Black Haw; 20th, Purple mulberry; 23d, Viburnum; 28th, Syringa fragrans.

June 1st, Locust tree—very late; 2d, White peony; 4th, Hudson strawberry ripe; 6th, Kalmia latifolia in bloom; 10th, Syringa Philadelphica; 13th, Catawba grape in bloom; 22d, China ailanthus; 23d, Purple mulberry ripe; 25th, Magnolia glauca in bloom; 27th, Catalpa; 28th, Early wheat ripe.

July 2d, Red cherry ripe; 4th, Red Antwerp raspberry ripe; 15th, Blackberry ripe.

ART. XXX.—*On the different Chemical Conditions of the Water at the surface of the Ocean and at the bottom, on Soundings;* by AUG. A. HAYES, Assayer to the State of Mass.

CONSIDERING the surface, which the ocean covers in comparison with any large extent of land surface, we might be led to expect a want of uniformity in the distribution of saline matter throughout its mass. Those parts reposing in immediate contact with saline deposits and many decomposing rocks, would every instant receive more soluble matters than contiguous portions, and while matter to be dissolved remained, the balance of distribution would be disturbed. Local differences are known to exist and are referred to the influence of evaporation, and to lower and upper currents, with great degree of probability. Still, the belief that the water of the ocean has existed during the lapse of great geological periods of time, with the same or even a large proportion of saline matter, must gradually give way, as facts connected with the decomposition of rocks are attentively studied.

The phenomena which form the subject of this communication, are only remotely connected with this point of unequal distribution; being related to *kind*, rather than quantity of saline parts.

The mass of ocean, exposed on its surface to the mixture of gases forming our atmosphere, absorbs both constituents, the oxygen in the larger proportion. Winds greatly favor this effect, and the increased quantity found in the water after storms, is referred to this action.

When ocean water, taken at the same moment from the surface and only one to two hundred feet under this surface, is subjected to the usual course of analysis, a larger proportion of oxygen is constantly found in the surface samples. Trials, made at points from the temperate to and within the torrid zone, corresponded, and only slight deviations were found in the moving water of the Gulf Stream. Another kind of evidence of this fact, is afforded by the observations made on the corrosion of the copper sheathing of vessels. Slight inequalities in the kinds of copper used exist; but when a large number of cases are included and time of observation is considerable, this influence is hardly seen. It is a general law, that copper sheathing corrodes most rapidly at those parts of the covered surface, where, by agitation, the most air is dissolved in the water passing in contact with it. The fact is well known, that sea-water, deprived of air, has no action on copper even after many years' exposure, and this relation becomes changed, when we allow the same water to dissolve air. Some persons who have noticed this uniformity of corrosion, at

the points where the water contains the most dissolved air, have attempted an explanation, on mechanical principles. They have assumed that greater friction between the moving surface and the water takes place at those points. It is not uncommon for vessels to make long voyages and return with the *chalked numbers of the sheets legible*, and active corrosion *seldom* takes place on those parts of the coppered surface, really exposed to the greatest friction.

If we assume that the oxygen of sea-water is almost wholly derived from solution of one part of the atmosphere, then the surface under existing conditions should contain the largest amount. The organized beings of the ocean, consuming the oxygen as diffused, would constantly diminish the quantity below and allow an inequality to exist.

The reactions taking place in the corrosion of copper by the surface water of the ocean, considered in all their particulars, become quite complex. Without entering minutely into these, it is sufficient to adopt the usual expression, that the oxydation and corrosion of copper take place in consequence of the decomposition of hydrochlorates, under the presence of oxygen and metal; a very common change, resulting in the production of oxyds and chlorids.

While pursuing the subject of copper corrosion at the surface, I was some years since led to examine samples of copper, which had remained some time at the bottom of the ocean. In these cases an opposite kind of action was at once recognized, and the observations have been so far multiplied, that I think a constancy of result will be observed in all cases on soundings.

Copper and bronze, and even a brass compound, were found thickly incrusted with a sulphuret of copper, formed often in crystallized layers, having a constant chemical composition, entirely free from chlorine or oxygen, the corroding agents of the surface. Specimens of copper and bronze from mud and clay at different depths, and in one instance from clean sand below a powerful rapid, have given thick layers of sulphurets of copper, or copper and tin.

These observations have been lately extended, and as they include other materials, I shall state them more particularly.

The Spanish vessel San Pedro de Alcantaro, was blown up off the coast of Cumana, in the year 1815, and a large amount of specie dispersed and sunk. A large part of the silver dollars has been recovered during the past year, by our enterprising countrymen, from a depth between fifty and eighty feet. The coin reposed in mud and was sometimes covered by a stratum of coral, from six to twelve inches thick.

Two pieces of the coinage of 1810 and 1812 were taken for analysis. The weight of such dollars, slightly worn, was 412

grs. nearly. When the coin of 1810 had lost its covering, it weighed 330 grains, or 82 grains of the substance of the dollar had assumed the state of a sulphuret. The other weighed 356·82 or less by 55·18 grs. By exposure during thirty-five years in one case, 100 parts of the coin had been destroyed to the extent of nearly 20 parts, the other 13·39, giving an average of 16·52.

These incrustations were crystallized distinctly and their composition was carefully determined. Water abstracted traces of chlorids of sodium and magnesia, with sulphate of lime only. Acetic acid took up a compound of chlorine, carbonate of lime and oxyd of copper, in minute quantity. The investing coating was removed from one coin by making it the negative of a single galvanic circle, in dilute sulphuric acid, so as to obtain the covering in sheets; a loss of sulphur taking place. Water acidulated with nitric acid, after several days, detached the covering from the other, and this sample was used for determining the sulphur, in the form of sulphuric acid, as well as the bases. Operating in this way, it was found that very small portions of chlorids of sodium, magnesium, and sulphate and carbonate of lime adhered to the incrustation, while the pure portion of this consisted of bisulphuret of copper with sulphuret of silver and gold; even the minute trace of the latter metal in the silver, being mineralized by sulphur.

Connected with this observation is another I have made on the corrosion of an alloy of 1 silver in 500 copper, used as sheathing, in which both metals united to chlorine and oxygen, and were removed rapidly and largely by surface water, as a simple metal would have been.

No opportunity has yet offered for continuing these examinations on copper and other metals obtained from great depths of water; and in calling the attention of chemists to this action, I hope to obtain results from those who are more favorably situated for observation.

The opposite tendencies of the two parts of the ocean on soundings being shown, a large mass, distinguished as "green water," is really placed as it were between the poles of a gigantic single galvanic circle, and we are thus enabled to explain many anomalous decompositions taking place within such limits.

In looking for the cause of the transfer of sulphur from its oxydized state, in saline compounds, to the metals on the bottom of the ocean, I have concluded that the waters from the land, exert a most important influence. These waters are never destitute of organic matter in a changing state. This matter dissolved from the surface of the earth or from rocks in percolating the strata, assumes a state in which it powerfully attracts oxygen. Waters holding this matter in solution, readily decompose sul-

phates of lime and soda, even when partially exposed to atmospheric air. The line at which the saline waters of the ocean and the under-land flow of water meet, is the place, where observations have shown that the greatest chemical action exists. Ordinary decompositions of sulphates by organic matter in ocean water, are hardly known to take place. The phenomena at once become distinct, when land waters are allowed to mix, and the water from deep wells in the vicinity of the ocean has a more highly marked chemical action, than rain water. The decomposition of the sulphates proceeds under the presence of carbonic acid, and carbonates of the alkaline earths are products of the change.

1 Pine St., Boston, January, 1851.

ART. XXXI.—*On the Limit of Perpetual Snow in the Himalaya;* by Lieut. STRACHEY.*

"IN this part of the Himalaya, it is not, on an average of years, till the beginning of December, that the snow line appears decidedly to descend for the winter. After the end of September, indeed, when the rains are quite over, light falls of snow are not of very uncommon occurrence on the higher mountains, even down to 12,000 feet; but their effects usually disappear very quickly, often in a few hours. The latter part of October, the whole of November, and the beginning of December, are here generally characterized by the beautiful serenity of the sky; and and it is at this season, on the southern edge of the belt, that the line of perpetual snow is seen to attain its greatest elevation.

The following are the results of trigonometrical measurements of the elevation of the inferior edge of snow on spurs of the Treslú and Nandádevi groups of peaks, made, before the winter snow had begun, in November, 1848.

Point observed.	Height as observed on face exposed to the East.			Height on face exposed to West. Observed from Almorah.
	From Almorah, (height, 5586 ft.)	From Binsar, (height, 7969 ft.)	Mean.	
No.	Feet.	Feet.	Feet.	Feet.
1	16,599	16,767	16,683	15,872
2	16,969	17,005	16,987	———
3	17,186	17,185	17,185	14,878
4	15,293	15,361	15,327	———

The points 1, 2 and 3 are in ridges that run in the southwesterly direction. The dip of the strata being to the northeast, the

* Jour. Asiatic Society of Bengal, New Series, No. xxviii, p. 287; cited from Humboldt's Views of Nature, Bohn's edition, p. 74.

faces exposed to view from the south are for the most part very abrupt, and snow never accumulates on them to any great extent. This in some measure will account for the height to which the snow is seen to have receded on the eastern exposures, that is, upwards of 17,000 feet. On the western exposures the ground is less steep, and the snow is said to have been observed at a considerable less elevation; but it was in very small quantities, and had probably fallen lately, so that I am inclined to think that its height, viz., about 15,000 feet, rather indicates the elevation below which the light autumnal falls of snow were incapable of lying, than that of the inferior edge of the perpetual snow. It is further to be understood, that below this level of 15,000 feet, the mountains were absolutely without snow, excepting those small isolated patches that are seen in ravines, or at the head of glaciers, which of course, do not affect such calculations as these. On the whole, therefore, I consider that the height of the snow-line on the more prominent points of the southern edge of the belt may be fairly reckoned at 16,000 feet at the very least.

The point No. 4 was selected as being in a much more retired position than the others. It is situated not far from the head of the Pindur river. It was quite free from snow at 15,300 feet, and I shall therefore consider 15,000 feet as the elevation of the snow-line in the re-entering angles of the chain.

I conclude, then, that 15,500 feet, the mean of the heights at the most and least prominent points, should be assigned as the mean elevation of the snow-line at the southern limit of the belt of perpetual snow in Kumaon; and I conceive that whatever error there may be in this estimate will be found to lie on the side of diminution rather than of exaggeration.

This result appears to accord well with what has been observed in the Bisseheir range. The account given by Dr. Gerard of his visit to the Shátúl Pass on this range, which he undertook expressly for the purpose of determining the height of the snow-line, contains the only definite information, as to the limit of perpetual snow at the southern edge of the belt, that is to be found in the whole of the published writings of the Gerards; and the following is a short abstract of his observations. Dr. Gerard reached the summit of the Shátúl Pass, the elevation of which is 15,500 feet, on the 9th of August, 1822, and remained there until the 15th of the same month. He found the southern slope of the range generally free from snow, and he states that it is sometimes left without any whatever. On the top of the pass itself there was no snow; but on the northern slope of the mountain it lay as far down as about 14,000 feet. On his arrival, rain was falling, and out of the four days of his stay on this pass, it either rained or snowed for the greater part of three. The fresh snow that fell during this time did not lie below

16,000 feet, and some of the more precipitous rocks remained clear even up to 17,000 feet.

The conclusion to which Dr. Gerard comes from these facts, is, that the snow-line on the southern face of the Bissehir range is at 15,000 feet above the sea. But I should myself be more inclined, from his account, to consider that 15,500 feet was nearer the truth; and in this view I am confirmed by verbal accounts of the state of the passes on this range, which I have obtained from persons of my acquaintance, who have crossed them somewhat later in the year. The difference, however, is after all trifling.

Such is the direct evidence that can be offered on the height of the snow-line at the southern limit of the belt of perpetual snow; some additional light, may, however, be thrown on the subject generally by my briefly explaining the state in which I have found the higher parts of the mountains at the different seasons during which I have visited them.

In the beginning of May, on the mountains to the east of the Rámganga river, near Námik. I found the ground on the summit of the ridge, called Champwá, not only perfectly free from snow at an elevation of 12,000 feet, but covered with flowers, in some places golden with Caltha and Ranunculus polypetalus, in others purple with Primulus. The snow had in fact already receded to upwards of 12,500 feet, behind which even a few little gentians proclaimed the advent of spring.

Towards the close of the same month, at the end of the Pindur, near the glacier from which that river rises, an open spot on which I could pitch my tent could not be found above 12,000 feet. But here the accumulation of snow, which was considerable in all ravines even below 11,000 feet, is manifestly the result of avalanches and drift. The surface of the glacier, clear ice as well as moraines, was quite free from snow up to nearly 13,000 feet; but the effect of the more retired position of the place in retarding the melting of the snow, was manifest from the less advanced state of the vegetation. During my stay at Pinduri the weather was very bad, and several inches of snow fell; but, excepting where it had fallen on the old snow, it all melted off again in a few hours, even without the assistance of the sun's direct rays. On the glacier, at 13,000 feet, it had all disappeared twelve hours after it fell.

On revisiting Pinduri about the middle of October, the change that had taken place was very striking. Now not a sign of snow was to be seen on any part of the road up to the very head of the glacier; a luxuriant vegetation had sprung up, but had already almost entirely perished, and its remains covered the ground as far as I went. From this elevation, about 13,000 feet, evident signs of vegetation could be seen to extend far up the less precipitous mountains. The place is not one at which the height

of the perpetual snow can be easily estimated, for on all sides are glaciers, and the vast accumulations of snow from which they are supplied, and these cannot always be readily distinguished from snow *in situ;* but as far as I could judge, those places which might be considered as offering a fair criterion were free from snow up to 15,000, or even 16,000 feet.

Towards the end of August I crossed the Barjikang Pass, between Rálam and Juhár, the elevation of which is about 15,300 feet. There was here no vestige of snow on the ascent to the pass from the southeast, and only a very small patch remained on the northwestern face. The view of the continuation of the ridge in a southerly direction was cut off by a prominent point, but no snow lay on that side within 500 feet of the pass, while to the north I estimated that there was no snow in considerable quantity within 1500 feet or more, that is, nearly up to 17,000 feet. The vegetation on the very summit of the pass was far from scanty, though it had already begun to break up into tufts, and had lost that character of continuity which it had maintained to within a height of 500 or 600 feet. Species of Potentilla, Sedum, Saxafraga, Corydalis, Aconitum, Delphinium, Thalictrum, Ranunculus, Saussurea, Gentiana, Pedicularis, Primula, Rheum, and Polygonum, all evidently flourishing in a congenial climate, showed that the limits of vegetation and region of perpetual snow were still far distant.

In addition to these facts it may not be out of place to mention that there are two mountains visible from Almorah, Rigoli-gúdri, in Garhwal between the Kailganga and Nandákni, and Chipula, in Kumaon, between Gori and Dauli (of Darma), both upwards of 13,000 feet in elevation, from the summits of which, the snow disappears long before the end of the summer months, and which do not usually again become covered for the winter till late in December."

These remarks are followed by an exposition of the errors into which Webb, Colebrooke, Hodgson, A. Gerard, and Jacquemont, have fallen. The heights assigned by these travellers "must all be rejected; nor can it be considered at all surprising that any amount of mistake, as to the height of the snow-line, should be made, so long as travellers cannot distinguish snow from glacier ice, or look for the boundary of perpetual snow at the beginning of the spring."

With regard to *the northern limit of the belt of perpetual snow*, Lieutenant Strachey's observations were made in September, 1848, on his way from Milam into Hundes, *viâ* Untadhúra, Kyungar-ghát, and Balch-dhúra, at the beginning of the month; and on his road back again, *viâ* Lakhnr-ghát, at the end of the month.

"Of the three passes that we crossed on our way from Milam, all of them being about 17,000 feet in elevation, the first is Wata-dhára, and we saw no snow on any part of the way up to its top, which was reached in a very disagreeable drizzle of rain and snow. The final ascent to the pass from the south is about 1000 feet. The path leads up the side of a ravine, down which a small stream trickles, the ground having a generally even and rounded surface. Neither on any part of this nor on the summit of the pass itself, which is tolerably level, were there any remains of snow whatever. On the ridge to the right and left there were patches of snow a few hundred feet above; and on the northern face of the pass an accumulation remained that extended about 200 feet down, apparently the effect of the drift through the gap in which the pass lies. Below this again the ground was everywhere quite free from snow. On the ascent to Wata-dhára, at perhaps 17,000 feet, a few blades of grass were seen, but on the whole it may be said to be utterly devoid of vegetation. On the north side of the pass, 300 or 400 feet below the summit, a cruciferous plant was the first met with.

The Kyungar pass, which is four or six miles north of Wata-dhára, was found equally free from snow on its southern face and summit, which latter is particularly open and level. The mountains on either side were also free from snow to some height; but on the north a large bed lay a little way down the slope, and extended to about 500 feet from the top. On this pass, a boragineous plant in flower was found above 17,000 feet; a species of *Urtica* was also got about the same altitude, and we afterwards saw it again nearly as high up on the Lákhur pass.

In our ascent to the Balch pass, no snow was observed on any of the southern spires of the range, and only one or two very small patches could be seen from the summit on the north side. The average height of the top of this range can hardly be more than 500 feet greater than that of the pass; and as a whole it certainly does not enter the region of perpetual snow. As viewed from the plains of Handes, it cannot be said to appear snowy, a few only of the peaks being tipped.

We returned to Milam *viâ* Chirchun. The whole of the ascent to the Lákhur pass was perfectly free from snow to the very top, *i. e*, 18,300 feet and some of the neighboring mountains were bare still higher. The next ridge on this route is Jainti-dhára, which is passed at an elevation of 18,500 feet, but still without crossing the least portion of snow. The line of perpetual snow is however evidently near; for though the Jainti ridge was quite free, and some of the peaks near us were clear probably to upwards of 19,000 feet, yet in more sheltered situations unbroken snow could be seen considerably below us; and on the whole I think that 18,500 feet must be near the average height of the snow-line at this place.

A brief recapitulation of the principal results of Lieutenant Strachey's inquiries shows that "the snow-line or the southern edge of the belt of perpetual snow in this portion of the Himalaya is at an elevation of 15,000 feet, while on the northern edge it reaches 18,500 feet; and that on the mountains to the north of the Sutlej, or still further, it recedes even beyond 19,000 feet. The greater elevation which the snow-line attains on the northern edge of the belt of perpetual snow is a phenomenon not confined to the Thibetan declivity alone, but extending far into the interior of the chain; and it appears to be caused by the quantity of snow that falls on the northern portion of the mountains being much less than that which falls farther to the south along the line where the peaks, covered with perpetual snow, first rise above the less elevated ranges of the Himalayas."

ART. XXXII.—*Analyses of the Ashes of certain Commercial Teas;* communicated by Prof. E. N. HORSFORD, of Harvard University.

1. *Souchong Tea; by Edward A. Spooner, of the Cambridge Laboratory.*

1*st Sample:*—per-centage of ash yielded by the tea, 5·48

A qualitative examination conducted according to the method of Will and Fresenius gave for the constituents of the ash, potassa, soda, lime, magnesia, peroxyd of iron, phosphoric, sulphuric, hydrochloric, silicic and carbonic acids, charcoal and sand.

A quantitive analysis gave the following per-centage of the several constituents.

	Results of analysis.	Per-centage, carbonic acid, charcoal and sand excluded.
Potassa,	3·31	3·70
Soda,	22·78	25·46
Lime,	10·40	11·63
Magnesia,	8·58	9·59
Peroxyd of iron,	7·53	8·42
Phosphoric acid,	11·29	12·62
Sulphuric acid,	9·07	10·14
Chlorid of sodium,	2·15	2·40
Silica,	14·35	16·04
Carbonic acid,	2·85	——
Charcoal and sand,	5·38	——
	97·69	100·00

2d Sample:—per-centage of ash, 6·106.
The analysis gave in 100 parts:

	Results of analysis.	Per-centage, unessential ingredients excluded.
Potassa,	40·51	44·96
Soda,	1·53	1·70
Lime,	7·90	8·77
Magnesia,	7·58	8·41
Peroxyd of iron,	6·13	6·80
Phosphoric acid,	10·33	11·46
Sulphuric acid,	6·27	6·96
Chlorid of sodium,	1·94	2·15
Silica,	7·92	8·79
Carbonic acid,	2·26	——
Charcoal and sand,	7·39	——
	99·76	100·00

2. *Oolong Tea; by Robert C. Tevis, A.B., of the Cambridge Laboratory.*

Per-centage of ash, 5·14
The analysis gave in 100 parts:—

	Results of analysis.	Per-centage, charcoal, sand and carbonic acid excluded.
Potassa,	11·57	12·38
Soda,	37·40	40·00
Lime,	7·19	7·68
Magnesia,	5·77	6·17
Peroxyd of iron,	6·71	7·18
Chlorid of sodium,	2·10	2·25
Phosphoric acid,	7·72	8·26
Sulphuric acid,	7·73	8·27
Silicic acid,	7·30	7·81
Carbonic acid,	2·30	——
Charcoal and sand,	3·72	——
	99·51	100·00

3. *Young Hyson Tea; by J. M. Hague, of the Cambridge Laboratory.*

Per-centage of ash, 5·94.
The analysis gave in 100 parts:

	Results of analysis.	Per-centage, carbonic acid, charcoal and sand excluded.
Potassa,	30·84	33·95
Soda,	8·42	9·26
Lime,	7·43	8·17
Magnesia,	6·17	6·79
Peroxyd of iron,	4·32	4·75

	Results of analysis.	Per-centage, carbonic acid, charcoal and sand excluded.
Chlorid of sodium,	4·24	4·66
Phosphoric acid,	15·12	16·64
Sulphuric acid,	4·40	4·89
Silicic acid,	9·90	10·89
Carbonic acid,	3·83	——
Charcoal and sand,	5·98	——
	100·65	100·00

4. *Ninyong Tea; by Charles S. Homer, Jr., of the Cambridge Laboratory.*

Per-centage of ash, 4·73.

The analysis afforded in 100 parts—

	Results of analysis.	Per-centage, carbonic acid, charcoal and sand excluded.
Potassa,	24·75	28·38
Soda,	11·24	12·88
Lime,	7·32	8·39
Peroxyd of iron,	16·84	19·31
Chlorid of sodium,	2·84	3·25
Phosphoric acid,	15·22	17·44
Sulphuric acid,	4·16	4·76
Silica,	4·86	5·59
Carbonic acid	4·01	——
Charcoal and sand,	9·09	——
	100·33	100·00

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Latent heat of Ice.*—Person has determined the latent heat of fusion of ice at 0° C. and at lower temperatures, and has ascertained that in order to obtain the *total* quantity of heat which is absorbed when ice becomes liquid, it is necessary to set out from a temperature somewhat below 0°. The experiments were made by means of a calorimeter founded on the method of mixtures. The loss of heat by radiation was compensated by placing the calorimeter in a space the temperature of which could be made to follow that of the calorimeter itself, and the method was verified by determinations of the specific heat of water at different temperatures which agree well with those of Regnault. The author first determined the specific heat of ice between −21° C. and −2° C., employing in the calorimeter a solution of salt the specific heat of which had been previously determined. The specific heat of ice between the limits above mentioned was found to be 0·48. In determining the latent heat the ice was formed into cylinders in the axes

of which were placed thermometers showing $\frac{1}{100}$th degree; the time of fusion in the calorimeter was on the average about 12 minutes. It was found that the latent heat of fusion of ice was very nearly constant setting out from a temperature of $-2°$, and was then represented by 79·97. From this it may be inferred that ice approaches very near its point of fusion without sensibly changing its consistence, the slight softening which precedes the fusion being comprised within an interval of 2 degrees: the passage of ice from a solid to a liquid state though sufficiently well defined is still effected by degrees and not abruptly. It will be remembered that De la Provostaye and Dessains on the one hand, and Regnault on the other, had found for the latent heat of ice the number 79; the experiments of Regnault had however clearly shown that this number was not constant but increased as the initial temperature of the ice diminished at least as far as $-0·61$, for which the corresponding latent heat was 79·71.—*Ann. de Chimie et de Physique, Sept.*, 1850.

2. *Liquefaction of Gases.*—Berthelot has applied the expansive force of heated liquids to the liquefaction of gases upon a small scale. A thick glass tube having a small bore is to be sealed at one end and then filled with pure and dry mercury free from air; the open end of the tube is then to be drawn out to a capillary orifice, without diminishing the ratio between the thickness and the interior diameter of the tube. The column of mercury is then to be heated in a water bath and the point of the tube kept in an atmosphere of the gas which it is wished to condense; when the tube is allowed to cool a portion of the gas equal to that of the mercury which has flowed out enters; the tube is now to be withdrawn and the point sealed; then the column of mercury is to be again heated in the water bath when the gas will condense into a drop easily visible with a lens and in many cases with the naked eye. The author suggests the employment of the gas or solar microscope to exhibit the phenomena at once to a large audience. Ammonia, carbonic acid and chlorine were easily liquefied in this manner, the tube for chlorine having been filled with pure and concentrated sulphuric acid.—*Ann. de Chimie et de Physique, October*, 1850.

3. *Evolution of Light at the Negative Pole of the Galvanic Series.*—Moigno has presented to the Academy of Sciences in Paris a memoir on the experiments of Neeff in Frankfort on the development of light and heat in the galvanic circuit. The author witnessed in person the experiments of the German physicist and considers it proved, 1st, that *Light* always appears at the *negative* pole, and that this primitive light is independent of combustion, 2d, that the source of the *Heat* is properly the *positive* pole, and that this heat is originally *dark* heat, 3d, that Light and Heat do not unite in the instant of evolution but only after the intensity of each has reached a certain point; from this union ensue the phenomena of flame and combustion. The facts stated were further verified by means of De la Rive's apparatus in which the poles of the battery were made to terminate in two iron cylinders terminating in acute cones; it was easily found by the finger alone that the iron connected with the negative pole was still cold, when the other had already become very hot. The experiments were subsequently repeated in Paris by means of an apparatus contrived by Duboscq to

moderate and regulate the galvanic light; the author interrupted the circuit repeatedly by separating the carbon-poles from each other and then causing them to approach again; at every new contact the originally white light showed itself upon the carbon of the negative pole, but *soon after* the completion of the circuit the combustion began at the positive pole, the carbon here became hollowed out and emitted a far more brilliant light than that of the negative pole. The regulator of M. Duboscq appeared to leave nothing to be desired, the variations of the electric light becoming wholly insensible.—*Comptes Rend.*, xxx, 359, *and Pogg. Ann.*, 1850, *No.* 10, 318.

4. *Compounds of Phosphorus and Iodine.*—CORENWINDER has studied in detail the definite compounds of iodine and phosphorus obtained by dissolving the two substances together in bisulphid of carbon and to which we have already alluded.* The author infers from these researches that there exist but two compounds of phosphorus and iodine,—a biniodid and a teriodid; these may be obtained in the manner already described.* The biniodid of phosphorus has no analogue in the oxygen series of this substance; as already stated, it crystallizes in large orange red prisms which fuse at 110°; the fused liquid is of a beautiful clear red; it is decomposed by water yielding iodohydric and phosphoric acids together with a yellowish flocky matter which was not examined; the crystals must be preserved in sealed tubes. The teriodid, obtained by dissolving together 1 eq. of phosphorus with 3 of iodine, crystallizes in confused hexagonal plates which have a red color; heated in a water bath to expel the bisulphide they fuse and the liquid on cooling gives a garnet-colored mass. The bisulphid can however only be perfectly expelled by submiting the iodid to a temperature of from 50° to 60° and passing over it a current of dry air, it then crystallizes by fusion in prisms of very large dimensions and is perfectly pure; water decomposes it readily into phosphorous and iodohydric acids. The author has further remarked that when a current of dry chlorine is passed into bisulphid of carbon charged with phosphorus the gas is wholly absorbed, and when the liquid is supersaturated with chlorine and allowed to stand in a cool place, perchlorid of phosphorus crystallizes in well defined white crystals.—*Ann. de Chimie et de Physique*, *October*, 1850.

5. *On the employment of Hydrogen in Mineral Analyses.*—RIVOT has employed the reducing action of hydrogen for the separation of iron from associated irreducible oxyds. To separate iron from alumina the author precipitates the two oxyds together in the usual manner by ammonia; the precipitate is dried and ignited, and a weighed portion in a small weighed porcelain vessel is placed in a tube disposed horizontally in a furnace; the air is expelled by a slow current of dry hydrogen, and the tube is gradually heated to redness and maintained at this temperature as long as water is formed; the tube is then allowed to cool while the gas still passes through it; when cold the porcelain vessel is withdrawn and weighed; the loss of weight gives the oxygen in the peroxyd. As a control the iron may be dissolved out from the mixture by means of dilute nitric acid in the cold; pure ordinary acid diluted with

* This volume, p. 108.

30 times its weight of water takes up in the course of 24 hours the whole of the iron without a trace of alumina. The result obtained in this manner by operating upon artificially prepared mixtures of the two oxyds was satisfactory, though it must be remarked that the author employed the old equivalent of iron 339 in his calculations. The same process was also found to give accurate results in separating iron from zirconia, glucina, and oxyd of chromium, and in the analysis of ores of tin. [*Note.*—Should the accuracy of the methods here indicated be verified by other chemists, it might be advantageous to substitute a porcelain crucible with a bored cover and porcelain tube as recommended by Rosé for the far less convenient arrangement of Rivot.]—*Ann. de Chimie, October*, 1850.

6. *Capronic and Œnanthic Acids.*—Brazier and Gossleth have contributed many new and interesting facts to the chemical history of these two acids. Capronic acid was prepared from cyanid of amyl $C_{10}H_{11}Cy$, by distillation with an alcoholic solution of caustic potash; the capronate of potash thus obtained was treated with sulphuric acid and the capronic acid separated as an oily liquid which was purified by distillation; the boiling point of the pure acid was found to be 198° C.; toward the end of the distillation, however, the boiling point rose to 211° and there passed over a liquid which after rectification had a constant boiling point at 211° and proved to be capronate of amyl, $C_{10}H_{11}O+C_{12}H_{11}O_3$. By the dry distillation of capronate of baryta, the authors obtained among other liquid products caprone, $C_{11}H_{11}O$, as a colorless liquid, insoluble in water, soluble in alcohol and ether and boiling at 165° C.; gaseous products, probably hydrocarbons of the series CnHn, were evolved at the same time. By the action of nitric acid upon another body of the acetone series, butyrone C_7H_7O, Chancel obtained a new acid, nitropropionic acid $C_6H_4(NO_4)O_3+HO$; Brazier and Gossleth have studied the action of nitric acid upon caprone and have rendered the formation of a similar acid nitrovaleric acid, $C_{10}H_8(NO_4)O_3+HO$, highly probable. By the action of the galvanic current upon a solution of capronate of potash the authors obtained a new hydrocarbon identical or isomeric with the radical amyl, $C_{10}H_{11}$, and which had already been obtained by Frankland by the action of zinc upon iodid of amyl; they point out the remarkable fact that the action of zinc upon the iodid of an alcohol-radical $CnHn+_1I$, and that of the galvanic current upon an acid of the formula $Cn+_2Hn+_2O_4$, gives rise to one and the same product. By the electrolysis of œnanthate of potash, a homologous compound was obtained as an oily liquid boiling at 202°, having an agreeable aromatic odor, insoluble in water but soluble in alcohol and ether. Its constitution is represented by $C_{12}H_{13}$, and the authors term it provisionally Caproyl; by repeated distillation with a mixture of nitric and sulphuric acids caproyl yields capronic acid. Bromine has little or no action upon caproyl even in the sunlight; chlorine acts however powerfully converting the liquid into a tough mass with evolution of chlorohydric acid.—*Ann. der Chemie u. Pharmacie*, lxxv, 249.

7. *Amylo-sulphuric Acid.*—Kekulé has studied amylo-sulphuric acid and its compounds, $C_{10}H_{11}O, SO_3+SO_3, RO$; of the results obtained, however, the only one which deserves special notice is

that relating to the action of heat upon amylo-sulphate of lime. When amylo-sulphate of lime is submitted to dry distillation, carbonic and sulphurous acids are given off and two liquids are obtained differing in volatility; the more volatile boiled at 42° C., was colorless and without taste, highly fluid, lighter than water, readily inflammable and exhibiting a faint odor of garlic which could not be removed even by repeated distillation; its formula is $C_{10}H_{10}$, and it is consequently identical with amylene obtained by Balard by the distillation of amylic alcohol with chlorid of zinc. The substance analyzed was however not absolutely pure, but contained a small quantity of some sulphur-compound. The less volatile liquid obtained did not possess a constant boiling point—the portion boiling between 165°–175° gave pretty nearly the formula of amylic ether, $C_{10}H_{11}O$, with which however its boiling point does not correspond. From the results of this investigation the author infers that in the dry distillation of an amylo-sulphate one portion of the oxyd of amyl passes over as such, one portion resolves itself into amylene and water, a third part is completely decomposed into water, carbonic acid, and carbon, while a fourth forms with the sulphur of the sulphuric acid a sulphur compound in quantity too small to admit of investigation; half of the sulphuric acid remains in combination with the base, the other half passes off as sulphurous acid, sulphur, and some organic matter containing sulphur. —*Ann. der Chemie u. Pharmacie*, lxxv, 275, *September*, 1850.

8. *New allotropic modification of Phosphorus.*—Schrötter has demonstrated that the change of color produced in phosphorus by the action of light is independent of the presence of oxygen; that it occurs even when the phosphorus is surrounded with an atmosphere of pure and dry hydrogen, carbonic acid, or nitrogen, and that it is due simply to the passage of the element into an allotropic state or form. Precisely the same change was produced by exposing phosphorus for some time to a temperature of 226° C.; the mass assumed a fine red color and became gradually less fluid, darker, and finally perfectly opaque. The precise temperature at which the change takes place could not be determined inasmuch as a less degree of heat produces in a longer, the same effect which a higher temperature produces in a shorter, time. The joint action of heat and light was also found more efficacious than either of these agents separately. The author compares the two allotropic modifications of phosphorus with those of carbon; the diamond when strongly heated passing into an amorphous state and becoming black and opake. Amorphous phosphorus is most readily prepared by exposing common phosphorus to the action of heat or light, and then dissolving out the unchanged substance by means of bisulphid of carbon and filtering, taking care to keep the filter full of liquid till a portion of the filtrate evaporated on a strip of platinum no longer leaves a trace of phosphorus. The substance on the filter is to be boiled with a solution of caustic potash of density 1·30 and washed, first with pure water, then with very dilute nitric acid, and finally again with pure water. The new modification of phosphorus is an amorphous powder, without lustre, and of a color which varies from scarlet-red to dark carmine-red but which may become dark brown or brownish black: when washed it becomes violet, recovering its original color when cold. Its density at 10° C. is 1·964. Amorphous

phosphorus is insoluble in bisulphid of carbon, alcohol, ether, naphtha and perchlorid of phosphorus; boiling oil of turpentine takes up a small quantity of it; in the air it remains wholly unchanged. It is not luminous in the dark at ordinary temperatures but becomes slightly so near the temperature at which it ignites. Chlorine acts upon amorphous phosphorus at the ordinary temperatures but without evolution of light, yielding terchlorid or pentachlorid according to the quantity of chlorine; bromine unites with it with a vivid ignition; iodine has no action at common temperatures, but when the two substances are heated together in an atmosphere of any indifferent gas they unite quietly forming an orange yellow iodid and a less volatile, scarlet, crystalline compound, probably a teriodid. A solution of caustic potash dissolves amorphous phosphorus on boiling with evolution of phosphuretted hydrogen not spontaneously inflammable: the more concentrated the solution the more easy is the decomposition, the finely divided amorphous phosphorus assuming a dark chocolate brown color. Schrötter considers it probable that the black phosphorus of Thenard is the same allotropic modification with that which he has described. Nitric acid readily oxydizes amorphous phosphorus, the increased surface of the latter forming many points of attack. Finally, neither copper nor other metallic substances are precipitated from their solutions by amorphous phosphorus. The author recommends this substance in an economical point of view for the preparation of friction-matches and percussion caps, as it possesses over ordinary phosphorus the great advantages that it is neither affected by the moisture of the atmosphere nor injurious to the health of the workmen. In a second paper the author fully confirms the results which he had previously obtained, and adds among other interesting facts the remarkable one that common phosphorus is capable of decomposing water at a temperature between 250° C. and 260° C. It should have been stated above that the amorphous modification of phosphorus is reconverted into common or crystallizable phosphorus when heated above its boiling point in an atmosphere of hydrogen or nitrogen.—*Pogg. Ann.*, 1850, *No.* 10.

9. *Theory of Organic Radicals.*—Kolbe has published an elaborate and most interesting memoir on the chemical constitution and nature of the organic radicals. The paper however is not one which readily admits of condensation, and we must therefore refer to the original.—*Ann. der Chemie u. Pharmacie*, lxxvi, 1.

10. *On a compound of Chlorine, Phosphorus and Nitrogen.*—Gladstone has studied a compound of chlorine, nitrogen and phosphorus, originally discovered by Wöhler and Liebig, but not investigated by them. The chloro-phosphuret of nitrogen is always formed when pentachlorid of phosphorus is saturated with ammonia, and its formation is independent of moisture in the ammonia employed; no traces however are formed when terchlorid of phosphorus is saturated in a similar manner. When 1 part of pentachlorid and 2 parts of dry sal-ammoniac are heated together in a flask connected by means of bored corks and tubes with two or more receivers, the chloro-phosphuret sublimes, in the first receiver which is kept cool a colorless liquid appears containing a small quantity of a white powder, while chlorohydric acid gas passes off and is condensed in the second receiver in

which water is placed. The chloro-phosphuret of nitrogen is purified by crystallization from ether; at ordinary temperatures it is a solid crystalline substance which at 110° C. fuses to a clear liquid and begins to boil at 240°. The crystals obtained by sublimation are rhombic prisms, the acute angle of which measures 48°–49° and is sometimes replaced by a plane: in crystals obtained from alcoholic or etherial solutions the replacement of the acute angle is common. The density of the crystallized compound is somewhat greater than that of water, that of the fused substance somewhat less; on heating, dense vapors are given off, which leave a peculiar and rather agreeable smell. It is perfectly insoluble in water, soluble on the contrary in alcohol, chloroform, benzole, oil of terpentine, and particularly in ether. Powerful oxydizing agents decompose the chloro-phosphuret of nitrogen with formation of phosphoric acid; alcoholic solutions of potash, soda and ammonia also decompose it, forming chlorids and other salts of the bases used. The empirical formula of the chloro-phosphuret is $N_2P_3Cl_5$, which corresponds precisely with the results of Wöhler and Liebig. By the action of an alcoholic solution of caustic potash a new salt was obtained which gave with persalts of iron a white flocky precipitate resembling common phosphate of iron, but soluble in dilute acids and perfectly soluble in ammonia; its formula was found to be Fe_2O_3, P_2NO_5+4HO. Other salts of the same acid were formed, of which it will be sufficient to indicate the formulas

$$3CuO, P_2NO_5+5HO$$
$$3AgO, P_2NO_5+5HO$$
$$3BaO, P_2NO_5+2HO$$
$$3KO, \ P_2NO_5+5HO$$

The author proposes to return to the subject and to describe other products of the decomposition of the chloro-phosphuret of nitrogen: the new salts are termed nitro-phosphates; the acid was also isolated as a semi-fluid uncrystallized mass, and when super-saturated with ammonia gave with sulphate of peroxyd of iron a clear red solution which was considered the most characteristic and simple test.—*Ann. der Chemie u. Pharmacie*, lxxvi, 74.

11. *Quantitative separation of Potash and Soda.*—Rose has found that the fluo-silicates of potassium and sodium are wholly insoluble in a liquid containing alcohol. When fluo-silicic acid in excess is poured into a solution of a potash or soda salt and a volume of strong alcohol equal to that of the whole liquid is added, the whole of the potash or soda present is precipitated in the form of a fluo-silicate which is to be washed with strong alcohol diluted with an equal volume of water. Baryta may be separated from its solutions in a similar manner; a very small proportion of alcohol however suffices for its complete precipitation.—*Monats-bericht der Akademie der Wissenschaften zu Berlin, July*, 1850.

12. *Constitution of Tourmaline.*—Rammelsberg has communicated to the Royal Academy of Berlin the results of the analyses of thirty varieties of this remarkable mineral. Admitting the isomorphism of boric and silicic acids, the author arrives at the conclusion that as in the cases of feldspar and mica, the ratio between the quantities of oxygen in the protoxyds and the quantities in the sesquioxyds and the

two acids is different for different tourmalines. The ratio in question was found to be

in six varieties	= 1 :	3 :	5	spec. grav. mean		3·05
in eight "	= 1 :	4 :	6	" " "		3·10
in six "	= 1 :	6 :	8	" " "		3·20
in six "	= 1 :	9 :	12	" " "		3·08
in four "	= 1 :	12 :	15	" " "		3·04

The author divides the tourmalines into two classes:—A. Dark (brown or black) tourmalines; these contain no lithia, and the first member of their formulas is always a bisilicate ($\dot{R}^3\ddot{S}i^2$.) B. Light (blue, green and red) tourmalines; these contain lithia, and the first member of their formulas is always a trisilicate ($\dot{R}\ddot{S}i$); this class includes the transparent varieties. Class A, is further subdivided into 3 groups, for which Rammelsberg proposes the following names.

(1.) *Magnesia tourmalines.*—Oxygen ratio 1 : 3 : 5. Sp. Gr. 3·05. Formula $\dot{R}^3\ddot{S}i^2+3\dot{R}\ddot{S}i$. These contain the maximum of magnesia but very little iron. In this group belong the yellow and brown varieties from Gouverneur, N. Y., Orford, N. H., Monroe, Ct., Windisckappel in Carinthia, Eibenstock in the Harz, and the Zillerthal.

(2.) *Magnesia-iron tourmalines.*—Oxygen ratio, 1 : 4 : 6. Sp. Gr. 3·1. Formula $\dot{R}^3\ddot{S}i^2+4\dot{R}\ddot{S}i$. These contain on an average from 6–9 per cent. magnesia, and 3–14 per cent. oxyds of iron. This group embraces the apparently black varieties from Pennsylvania, Haddam, Unity, Ramfossen in Norway, Godhale in Greenland, St. Gotthard.

(3.) *Iron tourmalines.*—Oxygen ratio, 1 : 6 : 8. Sp. Gr. 3·2. Formula $\dot{R}^3\ddot{S}i^2+6\dot{R}\ddot{S}i$. These contain the maximum of the oxyds of iron (12–18 per cent.) but very little magnesia. In this group we find the black tourmalines of Bovey-Tracey in England, Andreasberg in the Harz, and from Saar in Moravia, Krummau in Bohemia and Langbielau in Silesia.

Class B comprises two groups.

(4.) *Iron-manganese tourmalines.*—Oxygen ratio 1 : 9 : 12. Formula $\dot{R}\ddot{S}i+3\dot{R}\ddot{S}i$. Sp. Gr. 3·08. These are characterized by containing both metals. They comprise the green, blue and violet varieties—the green from Elba, Paris in Maine, Brazil, and Chesterfield, Mass., the dark brownish-violet from Elba, and the blue from Sarapulsk in the Ural.

(5.) *Manganese tourmalines.*—Oxygen ratio 1 : 12 : 15. Sp. Gr. 3·04. Formula $\dot{R}\ddot{S}i+4\dot{R}\ddot{S}i$. These are red or nearly colorless varieties free from iron, as those from Elba, Paris in Maine, Schaitansk in the Ural and Rozena in Moravia.

In both classes tourmalines are found which are perfectly opake when cut parallel to the axis and examined in polarized light.

The author has further examined the micas and their relations to the tourmalines. The so-called potash-micas which have commonly a white color, were found to be divisible into three groups in which the oxygen ratios of the alkalies, alumina and acid are 1 : 6 : 9, 1 : 9 : 12, 1 : 12 : 15;* the second and third of these groups are identical with the fourth and fifth of the tourmalines.—*Monatsbericht der Akademie der Wissenschaften zu Berlin, July*, 1850, *and Pogg. Ann.*, 1850, No. 8 and 9. W. G.

* The ratio 1 : 12 : 15 is incorrectly deduced by Rammelsberg, by making $\frac{1}{4}$: 9 : 12, the true ratio, equal to 1 : 12 : 15, whereas it should be 1 : 12 : 16, as shown by Mr. Dana in his Mineralogy, p. 687, and in this Journal, vol. x, p. 114.

13. *Manganese in the urine;* by Prof. E. N. Horsford.—By evaporating fifty cubic centimeters of normal human urine over a water-bath, in platinum, to dryness, and igniting the residue, I have observed, in three of fourteen trials, on as many different occasions, unequivocal traces of *manganese*. The presence of this body in the ashes of several varieties of tea, coffee, potato, and squash, which has recently been demonstrated in the Cambridge Laboratory, leaves no doubt as to the source from which the manganese may have been derived.

The above observations relieve the experiments of Millon,* which led him to believe in the existence of manganese in the blood, from the imputation of Melsens,† that the metal may have been supplied from the vessels or reagents employed in the examination.

II. Mineralogy and Geology.

1. *Liebigite;* by J. Lawrence Smith.—This mineral, which I discovered about two years ago on a specimen of pitchblende from Adrianople, Turkey, along with another new mineral that I called Medjidite, exists in one of the European localities of pitchblende, namely, Johanngorgenstadt. The first specimen I found was in the cabinet of the School of Mines at Paris; there is another in the Yale College cabinet, and a third in Prof. Shepard's collection. It exists as a thin, yellowish, apple-green coating, semitransparent, easily detached from the surface of the pitchblende, and is instantly recognized by heating it on a piece of platinum foil, when it loses water, blackens at a red heat, and on cooling becomes orange red. It also effervesces violently with the strong acids, furnishing a test of uranium and lime. A European locality being now known, there will not be much difficulty in obtaining specimens. I also think that I have found the Medjidite from specimens of the same locality, but not having such a marked test for this mineral, I could not decide on the little I obtained from a specimen which is in the cabinet of the Garden of Plants.

2. *On the Geology of Spain;* by Don Joaquin Ezquerra del Bayo, (Quart. Journ. of the Geological Society, November, 1850. p. 406.)—In order to give a general idea of the geological constitution of our country, it may be considered as consisting of three principal divisions, viz. the Crystalline or Gneissoid formations; the Transition formations; and the Secondary. The first predominate almost exclusively in the western portions (not including Portugal), in the whole of the ancient kingdom of Galicia, and extends through Astorga, Zamora, Salamanca, Placencia, Cáceres, Mérida, Lleréna, Aracéna, and Rio Tinto, to the north of Seville and to the neighborhood of Italica, the birth-place of the Emperor Trujan, now called Sancti Ponce. It must however be observed, that as yet, for want of detailed observations, we have no definite lines to mark the limits of the three formations above mentioned. We can say only that the gneiss rocks occupy about a fifth of the surface of the soil, extending longitudinally from north to south, but throwing out, as it were, ramifications toward the east.

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* Journal de Ph. et de Chim., 3 Sér., t. xiii, p. 86–88.
† Ann. de Chem. et de Phys., 3 Sér., t. xxiii, p. 388–392.

These gneiss rocks are probably secondary or primary formations, altered by the plutonic rocks which have penetrated them. These are generally ordinary granite, more or less coarse-grained, and sometimes traversed by veins or dykes of porphyritic granite. Only at the northern extremity, viz. between Aracéna and Lleréna, in the villages of Zufre and Santa Olalla, is a great syenitic outburst visible.

The most important of these granitic ramifications to the east, is that which passes by the Sierra de Gridos, Sierra d'Avila, and the Guadarrama, to Somo Sierra, in a direction from southwest to northeast. The great granitic outburst of Truxillo and of the mountains of Toledo does not extend so far to the east. A third, which is not so well marked as the other two, *i. e.* does not appear on the surface with the same continuity, is that which has probably given its present form to the Sierra Morena. It terminates at Linares, in the province of Jaen.

The gneiss rocks in Spain do not generally abound in metalliferous deposits. There are some however of considerable importance. All the copper deposits of the district of Rio Tinto occur in talcose schist, in the vicinity of the granite. The famous mines of Guadalcanal and of Cazalla (now exhausted) are opened in chloritic schist, not far from the syenitic outburst. The rich argentiferous veins lately discovered at Hiendelencina, in the province of Guadalaxara, traverse the real gneiss, and are also not very distant from the granite of Somo Sierra.

The plutonic rocks themselves are still less rich in useful metals compared with their great development. The most important deposit in a rock of this character is the great system of lead and copper veins in the district of Linares, both for the abundance and excellent quality of the minerals. The granitic rocks in the neighborhood of Monterey in Galicia contain a small quantity of tin, as well as those of Carbajosa and Carbajoles, near Zamora, on the frontier of Portugal. To this last formation must also be referred the carbonate of lead and the antimonial-ochre of Losacio, in gneiss entirely surrounded by granite. These rich and abundant minerals of Losacio have not yet proved profitable to the speculator, for want of an economical method of carrying on their operations. The auriferous sands of Galicia, which the Romans worked on so large a scale, and from which the inhabitants still obtain a considerable revenue by washing, and those of the Guadiana and of the Tagus, which are slightly worked in Estremadura, are all derived from the disintegration of the granitic rocks. The auriferous sands of the Darro and the Gerril, sung by the Arab and Andalusian poets, are not worth mentioning; they are very poor, and are not derived from the same source.

The oldest sedimentary or transition rocks, in their different stages, the present forms of which are owing to volcanic eruptions, are in Spain most rich in mineral wealth. The whole range of the Cordilleras of the province of Granada down to the sea, and almost the whole coast from near Gibraltar to beyond Carthagena, belong to this period; consisting of slates, argillaceous schists, and mountain limestone, or rather metalliferous limestone. Fossils are very scarce. The Silurian formation is well characterized in the Sierra Morena, from Santa Cruz de Mudela to Almaden, with its remarkable deposit of Cin-

nabar. It also occurs in the mountain-chain of Asturia, which contains coal of good quality.

The secondary formations, which are shut in between the older rocks and the sea, occupy a great area in the centre of Spain, extending to the north and to the eastern coast. The greater part of these secondary rocks belong to oolitic and cretaceous periods; all the members of the series are fully developed except the Muschelkalk.

The Devonian formation is very limited. Some traces of it occur in the centre of the Asturias, and a still larger development occurs in the northern part of the province of Léon, which extends as far as Galicia, following a line parallel with the mountain-chain of Cantabria. In both these localities the Devonian rocks abound with coal of an excellent quality. That of the Austurias, which was already known at the close of the last century, not only in the Devonian, but in other formations, will hardly come into competition with other coals, unless the company by which it is worked agree to lay out larger sums in working it. That of Léon is more easily obtained, and although it has been known only for a few years, it is already a source of considerable industry in Castille. It is taken to Madrid for the cast-iron foundries and other works, as gas-lighting, &c.

On the Silurian rocks of the Sierra Morena, which we have alluded to, proceeding toward the south, reposes the great coal formation of Espiel and Belsuez, which may be called the basin of the Guadiato, the river by which it is traversed. This formation may be traced for a distance of fourteen leagues from west to east, and extends to within three leagues of Cordova. At Villanueva del Rio, on the right bank of the Guadalquivir, eleven leagues northeast from Seville, is a small basin of coal, extending over nearly a square league of ground. This coal is not of very good quality, being friable and dusty; nevertheless, owing to its situation so near the river and Seville, many thousand quintals are annually extracted. This is the whole extent of the true Carboniferous system in Spain.

The New Red Sandstone formation contains an extensive development of the Zechstein limestone, which forms almost the sole constituent of the Sierras of Alcazar, of the Sagra, of Cazorla, and of Castril, in the provinces of Jaen, Albacete, and Murcia. The *marnes irisées* have not yet been clearly made out; this is a great deficiency in our geology. There may be perhaps some traces in Moncayo, near Calcena in Aragon, and also in the mountains of Léon, and possibly in the province of Guadalaxara, towards Tamajon, with slight indications of coal. It is said that in La Mancha (now the province of Ciudad Real) the zechstein occurs with its *marnes irisées* and *todt-liegendes*, resting against the northern slope of the Sierra Morena; I have not seen it. At San Juan d'Alcaraz, in the Sierra of the same name, near the village of Riopar, the marls and dolomites are well characterized, and contain a rich deposit of calamine, the working of which is every day becoming more productive. I think I have discovered the Kupferschiefer of the Germans near Archidona, between Sierra de Lucena and Sierra d'Antequera.

The Jurassic or Oolitic formation constituted, to all appearances, the bottom of the sea during the cretaceous period, inasmuch as it

everywhere rises above the surface when the cretaceous formation is interrupted. There is, however, a considerable extent of it exposed, as *e. g.* the whole mountain range, which, commencing near Burgos, continues towards the east through the province of Soria, as far as Moncayo, and thence into Aragon, passing near Arina, as far as Feruel. This ridge of oolitic rock is slightly interrupted by the chalk and tertiary beds, but it again appears in the kingdom of Valencia as far as the town of the same name; so that, in fact, the oolitic formation can be traced from Valencia to Burgos for a distance of 180 Spanish leagues (900 kil.) forming an obtuse angle at the culminating-point of Moncayo. I have observed the same beds at Siguenza and Torremocha, in the province of Guadalaxara, in Andalusia near Cabra, in the province of Cordova, and in the Basque provinces, as is laid down in the Geological Map of France. It probably exists in other localities not yet accurately investigated.

The oolitic formations of Spain have in my opinion some remarkable features. They abound in metalliferous deposits of all kinds, generally scattered in small isolated masses, and seldom in veins. These beds were formerly worked with profit when mining was carried on on a small scale, and with the help of slaves. Now, however, minerals must be very rich and abundant to enable companies to make any return. Almost all those who have worked in the jurassic formation have been ruined. *Cuivre gris* or grey copper ore of good quality is found here as well as copper pyrites, both very argentiferous, but soon worked out. Near Barbadillo, at the extremity of the province of Burgos, at the foot of the Sierra de San Lorengo, a bed of this description is now worked, which, both for the richness and the quantity of the ore, is most promising. The non-argentiferous galena is generally more regular, and a few productive veins of sulphate and oxyd of antimony also occur, as, *e. g.* in the neighborhood of Ateca, in the province of Zarogoza.

In several places the rocks of the oolitic group have been affected by volcanic eruption, by which they have been altered, their color and structure changed, and all trace of fossil remains obliterated, so that it becomes difficult even for a practised geologist to classify them properly, Thus it is not extraordinary that travellers *en chaise de poste* have fancied that they saw in the centre of Spain variegated marls and red sandstones, trusting only to the external aspect of the rocks seen from the road. I am satisfied that further and more detailed observations will show that the oolitic and liassic formations are more extensively developed than has hitherto been supposed, *i. e.* that they will be discovered over a great portion of the south of the Peninsula.

Other phenomena, which further observation may perhaps tend to generalize, are the thermal springs which rise up in the jurassic formations at or near the point of junction with the more recent formations. We may mention, by way of example, the hot springs of Fitero in the province of Navarra, Arnadillo in the province of Logroño, and Alama near Calatayud. There are also cold sulphureous springs like those of Paracuellos in Aragon, and those of Gravalos in Castille. It must, however, be observed that these same phenomena also occur in the cretaceous formations, although not so frequently; amongst these latter

are the "Caldas de Catalogna," and the "Caldas des Asturias," with the geological conditions of which I am not quite acquainted, but I believe them to belong to the cretaceous beds. It is probable that similar cold sulphureous springs existed during the tertiary (pliocene) period; at least it is only by such a supposition that we can explain the origin of the vast deposits of sulphur which are worked at Hellin and Bénamaurel in the province of Albacete, and of that of Libros in the province of Teruel, the argillaceous beds of which are studded with *Planorbis* and *Limnæus* filled with native sulphur.

The Cretaceous formation covers the whole southern slope of the great chain of the Pyrenees, extending westward into the Basque country, to the mountains of Santander, and part of the Asturias. To speak more correctly, this cretaceous zone of the shore of the Cantabrian sea is rather a continuation of that which comes from France along the northern slope of the Pyrenees. The cretaceous zone of the southern slope also extends towards the west through Navarre, a portion of the Basque provinces, the province of Burgos, and the mountains of Léon, so that the great cretaceous deposit of the south of France and the north of Spain is divided in two by the transition and plutonic rocks of the Pyrenees, the jurassic rocks of Biscay, and the Devonian rocks of the Cantabrian mountain-chains. From Figueras in Catalogna to Oviedo in the Asturias is a distance of more than seven geographical degrees.

The Spanish cretaceous zone stretches towards the south with very little interruption, passing near Burgos, through Old Castille, the provinces of Soria and Guadalajara to Tamajon and Congostrina in the neighborhood of the celebrated mines of Hiendelencina, which we have already noticed. A ridge which passes by Segovia, the inclined strata of which rest against the granites of the Guadarrama, must be considered as a continuation of the same formation. The cretaceous beds probably exist more extensively in the centre of Spain, and particularly in the ancient kingdoms of Aragon and Valencia. I know only of a few particular spots, as in the province of Teruel, where they overlie the jurassic beds.

The cretaceous formations of central Spain also afford some phenomena which deserve the attention of the geologist. The most remarkable is the elevation of great tracts of country to a considerable height without losing their original horizontality, as the famous plain or plateau of Baraona, celebrated in the annals of Spanish fairies (Brujas or Witches), between Medinaceli and Almazan in Old Castille. It is nearly 5000 feet (1393 mèt.) above the level of the present sea. The plateau or table-land of Algora, province of Guadalajara, on the high road from Madrid to Zaragoza, corresponds to the white chalk (*craie blanche*), and is 4170 feet (1160 mèt.) above the sea. The village of Peñalcazar, in the province of Soria, bordering on that of Zaragoza, is built on a small plateau perfectly horizontal, whilst the neighboring hills consist of inclined beds of the same formation, and which nevertheless are not so elevated as the plateau itself. At Tamajon, in the province of Guadalajara, on the other hand, the horizontal portion is lower than the inclined beds. The same phenomenon, but on a larger scale, occurs in the valley of the Borunda, province of Navarre.

The great abundance of beds of lignite (*charbon*) distributed throughout the cretaceous formation of central Spain also deserves notice. In some respects they are not nearly as important as those of true coal (*houille*), but the fuel is often sufficiently good to be applied to all kinds of industrial purposes. It occurs at Rozas near Reynosa, at a spot not far from Burgos, at several places in the province of Soria, between the town of that name and Moncayo; in the Basque provinces, and perhaps also in the Asturias. The great saliferous deposits are also a peculiarity of our cretaceous formations; the celebrated mine of Cardona in Catalogna may be mentioned, as well as Pozo del Rey in the province of Burgos, the salt springs of Añana, province of Alana, which produce more than 50,000 fanegas of salt,* &c.

The formations of the tertiary period, both the marine and the lacustrine, overlie all kinds of beds of older date; as, for example, in Catalogna they rest on the chalk, at Valencia on the jurassic, in Andalusia on the transition beds, in the valley of the Guadalquivir, on the various surrounding beds and even on granite. The actual configuration of the Spanish soil must have been already marked out at the commencement of the tertiary period, with the exception of some partial modifications, for in general all the beds are in a horizontal position; Col. Silvertop only quotes along the coast of Andalusia some upheaved beds of the eocene period. It must however be observed, that along the same shore there are some spots, as at Cuevas de Vera Sierra Almagrera, where the marine tertiary formation attains an elevation of 900 feet, which gives rise to the question as to whether the waters of the Mediterranean reached that height before the Straits of Gibraltar were broken through, or whether the shore itself has been partially upraised since that period. Among the numerous fossils which are found on this coast, there are some species of mollusca of a most extraordinary size; in the vicinity of Cuevas de Vera are also found entomed the remains of elephants, isolated and distributed in particular directions, which were washed down by the streams into the ancient sea, all proving the existence at that period of a more tropical climate than is found at present in this district.

Our tertiary marine formations cover almost without interruption the whole shore of the Mediterranean, and even beyond the Straits in the province of Cadiz; I am not sure whether they extend into Portugal, although it is probable. This tertiary zone extends but a short distance into the interior, except in the valley of the Guadalquivir, where it may be traced without interruption from Cadiz and San Lucar, ascending the river, to Andujar and Liñares, where it rests upon granite, covering up the rich veins of galena which penetrate this plutonic mass of hills. On the northern slope the tertiary beds are but slightly developed. In the interior, I know of no marine tertiaries except in the neighborhood of Burgos towards the north, which must have been a salt lake at that period. In this formation we find a few deposits of lignite, the most important of which is probably that of Utrillas, near Montalvan, in the province of Teruel.

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* A *fanega* is equivalent to rather more than 99¼ *litres* or 1·6 bushels; and a fanega of salt weighs about 112 Spanish pounds (or 113·6 lbs. av.).

In the third volume of our 'Annales de Minas,' published in 1845, I have given a general account of the great lacustrine formations of central Spain. The most important of all, and that which has been best examined, is what I have called the basin of the Douro (Cuenca del Duero), the surface of which is nearly forty Spanish leagues square,—3400 square kilom. To the west and south it rests on the crystalline or metamorphic formations of Galicia and of the frontiers of Portugal, of the Sierra d'Avila, and of the Guadarrama; to the north on the Devonian beds and on the chalk of the mountains of Léon; and to the east on the cretaceous beds. The lacustrine basin of the Ebro is also very considerable, but I do not know its exact limits. It is, perhaps, somewhat longer, following on both sides the course of the river; but it is not so broad. It rests almost everywhere on chalk, and partly on the jurassic beds. The basins of the Tagus and of the Guadarrama are separated from each other only by ramifications of the mountains of Toledo. The former, which is the most extensive, is placed exactly in the centre of Spain, and includes the capital. The fetid lacustrine limestone of Culmenar serves, as well as the granite of the Guadarrama, for architectural constructions, and is also used for statuary purposes, on account of its preserving almost indefinitely its natural whiteness. We also possess other small detached lacustrine deposits in the center of Spain, as *e. g.* at Libros near Teruel, at Calatayud, where fine specimens of sulphate of magnesia are collected, at Hellin and Benamaurel, already quoted for the production of sulphur, at Molina d'Aragon with its *Neritina*, nov. sp., and several other localities.

It is well known that the surface of Spain is very mountainous and broken up. The only plain of any extent is that of La Mancha in New Castille, from Tembleque to Santa Cruz de Mudela, a distance of twenty leagues, and elevated more than 2000 feet above the level of the sea. All the other lacustrine plains of the tertiary period have been washed out and furrowed by ante-historic torrents, and by the great rivers which traverse them, which have carried off the greater portion of their mass, and have moreover cut out the ravines which surround the partial and isolated hills, the horizontal summits of which once formed the bottom of the ancient lake. Other plateaux, on the other hand, are, as we have already pointed out, the bottoms of the cretaceous ocean, which, while being upraised to a considerable elevation, have accidentally preserved their original horizontality. In all the other formations, and even in the cretaceous beds, the strata have generally been tilted in a thousand ways, dipping in every direction, and with every possible degree of inclination, being sometimes quite vertical and even partially reversed. On seeing all these upheavals, all these dislocations, and all the different characters of mountains which have resulted therefrom, it is at once evident that many instances of eruptive rocks must be looked for.

In point of fact our soil has never been at rest, nor is it so even at present. The plutonic eruptions which have pierced the gneissoid rocks have been already pointed out in the western districts; the euphotides, diorites, and black porphyries are more frequent in the central parts of Spain; and the trachytes are almost exclusively confined to the shores of the Mediterranean, and particularly to the southern por-

tion between Marbella and Carthagena. The remarkable and singular deposit of quicksilver of Almaden and Almadenejos must have been occasioned by the action of the euphotides and other analogous volcanic rocks which have burst forth in this district and moulded the mountains or Sierras in such a singular manner. The veins and other metalliferous deposits of Charthagena, Mazarron, and Sierra Almagrera, which yielded such wealth to the Carthaginians under Hannibal, and from which we still derive considerable benefit, are certainly contemporaneous with the basalts of Cabo-de-Gata and of Vera, and the trachytes of Mazarron.

Earthquakes are still often felt at Granada and along the coast of the province of Alicante, where their effects have been very disastrous. Much further in the interior, in the small Sierra del Tremédal or district of Albarracia, in the province of Teruel, eruptions and shocks have been frequent since the most remote periods; the black porphyry is there seen traversing the altered strata of the oolitic formation. The old inhabitants of the country speak of sinking of the ground and of the escape of sulphureous gases when they were young; these same phænomena have occurred during four consecutive months of the preceding winter, accompanied by earthquakes, which have caused considerable mischief to the buildings of seven villages situated within a radius of two leagues. They have not however been attended with any loss of life, on account of the inhabitants hastening to abandon their dwellings at the first indication of danger.

3. *Ascent of Popocatepetl*, (Athenæum, No. 1209.)—After describing the ascent, the following particulars are mentioned with reference to the crater.—The crater has somewhat the form of an irregular parallelogram, of perhaps a league in circumference, and four or five hundred yards in width. It is a vast barranca,—the bottom of which is strewed with large stones and masses of rock, which have detached themselves from the sides and top edge. From the point where we first saw it, it is about a thousand feet deep,—and the side is as perpendicular as walls. We were quite unprepared for so grand an object. In one part of the bottom we saw what appeared to be a small pond of sulphur,—which was boiling away at a great rate, and sending up a dense volume of smoke. This was fortunately carried to our lee by the wind,—otherwise we should have been half stifled. Most of the smoke deposits itself in the crater in the form of sulphur,—but a great body rises much higher. People who have reported that they had seen smoke issuing from the top have been hitherto doubted:—but there is now a good number of us ready to swear as to the activity of the volcano. The small pond of sulphur to which I have alluded, appeared, from the height at which we were, to be about two feet square. It afterwards became enveloped in the smoke; and finally was again visible,—but much larger than before,—say six or seven feet square. While we were admiring this sight, we heard a noise like thunder; and saw on the opposite side of the crater some large rocks detach themselves from the edge, and roll, or rather fall, to the bottom. This took away the desire to go down which we had previously entertained. During our stay at the top (about four hours and a half), we heard the same noise eight or ten times.

After admiring the crater for some time, we went down to the hut. T. set up his barometer, and we took the observations:—we also boiled water with a spirit lamp. It boiled at 184° Fahr.:—the barometer stood at 16·015 in., and the thermometer at 2° Centigrade. By both calculations, the elevation above the ocean is about seventeen thousand feet. We took observations the previous night at Hamacas:—the barometer showed 19·194 in., and the thermometer 11° Centigrade. Water boiled at 192° Fahr. This elevation is a little more than twelve thousand feet.

4. *On Hydrargillite with the Corundum of Pennsylvania;* by T. F. Seal, (In a letter to one of the Editors, dated, Philadelphia, Feb. 3, 1851.)—In reading the last number of the Journal of Science I was much interested with Dr. Smith's paper on the Corundum and accompanying minerals of Asia Minor.

I have recently examined a mineral which we have long considered a steatitic coating on the corundum of Unionville, Pa. Alone, before the blowpipe, it instantly changes from its natural flesh color to a snow-white, and on the edges becomes enameled. With the cobalt solution, it gives a fine blue color. Although I am unable to get an analysis made at present, I think we may safely infer that it is the same hydrargyllite that occurs on the corundum of Asia Minor, as described by Dr. Smith in his memoir. He speaks of it as being rare. With us it occurs on a large proportion of the corundum crystals of the region. I have seen one crystal with this coating extending half an inch beyond the termination of the corundum and preserving the form of the corundum. Sometimes there is found on the *masses* of corundum a mammillary incrustation having a fibrous appearance which I take to be the same mineral. I have also found a thin coating of the albite rock of this locality having more distinctly the Gibbsite appearance. It appears as a *small mammillary* incrustation, (like the emerald-nickel of Lancaster Co., Pa.) of a grayish white color; before the blowpipe, with cobalt solution, it gives a bright blue very readily. I judge it to be the same mineral as the coating on the crystals of corundum.

The Unionville corundum has a higher specific gravity than that of Asia Minor. According to Mr. Joel Baily of Chester Co., it ranges from 3·90 to 4·10. I have many times looked for diaspore but without success. Some small crystals have the appearance of diaspore but they are too minute to make out their form. They do not decrepitate by heat, but according to Berzelius this is not a constant character.

5. *On Rhode Island Coal;* by A. A. Hayes, (From a letter to one of the editors, dated Boston, Feb. 3, 1851.)—Within a few weeks I have visited the Portsmouth company's coal mines on the island of Rhode Island, with reference to the economical use of the coal, and was much surprised to find so important beds, almost within our borders. About twenty-two thousand tons have been removed, fairly opening the workings, which can be so enlarged as to employ two hundred miners with every prospect of profit to a large amount.

The coal is in favor here for large fires and being sold at one fourth less price than that of Pennsylvania, meets a want which has long existed.

III. Zoology.

1. *Conspectus Crustaceorum quæ in Orbis Terrarum circumnavigatione, Carolo Wilkes e Classe Reipublicæ Fœderatæ Duce, lexit et descripsit* J. D. Dana.—Pars VI.*

Hyas lyratus.—Carapax† lyratus parce minutè tuberculatus, pone oculos alatè expansus, marginibus alæ antico posticoque subæquis, parallelis, margine externo excavato, rostro lævi, cornubus acutis, rectis. Pedes antici subtiliter pubescentes, brachio carpoque margines pustulatis, manu gracili. Pedes 8 postici longi, graciles, subtilissimè pubescentes.

Hab. ad oras Oregonenses.

Libidoclea coccinea.—Coccinea. Carapax orbiculari-triangulatus, sparsim tuberculato-spinosus et paulo subtiliter granulosus, rostro sat brevi. Pedes subtilissimè granulosi, tenues, digito paris 1mi subulato et basin non tumido, articulo paris 2di 3tio valde breviore quam carapax, tarsoque parce breviore quam articulus quintus, articulo 4to pedum 8 posticorum supra complanato et lævi. Articulus maxillipedis externi 3tius anticè integer.—Long. 2″ 4½‴.

Hab. in mari profundo juxta Patagoniam orientalem.

Genus PUGETTIA, *Dana.*—Rostrum, oculos, antennasque externas *Halimo* affinis. Articulus pedum 8 posticorum 5tus cylindricus.

Pugettia gracilis.—Mediocris. Carapax lyratus, paulo convexus, latus, pone oculos utrinque largè triangulato-expansus cum angulo acuto, margine postero-laterali spinâ crassâ armato, latitudine ante-medianâ vix minore quam latitudo post-mediana, regione medianâ tumidâ, minutè bituberculatâ. Pedes antici crassi, longi, brachio supra carinato, dentato, carpo bicarinato, digitis fere omnino contiguis. Pedes octo postici nudiusculi, articulis 3tio 5toque subcarinatis, 4to dorsum depresso, 5to infra versus apicem penecillum setarum brevissimum ferente.—Long. 16‴.

Hab. in maris Oregonensis freto "Puget."

Pugettia Richii.—Sat grandis. Carapax subtriangulato-ovatus, pone oculos alatus, alâ bilobatâ, lobis acutis, posteriore elongato et fere transverso; spinâ laterali subposticâ grandi; regione medianâ 4 tuberculis spiniformibus armatâ, cardiacâ uno, postremâ uno, postero-laterali utrinque duobus. Pedes antici longi, crassi, brachio paulo tuberculato, margine antico subtilissimè scalpto, carpo valde cristato, digitis (*maris*) latè hiantibus, apicem denticulatis, digito mobili versus basin infra unituberculato.—Long. 2″.

Hab. in mari juxta Californiam.—*W. Rich.*

Micippa hirtipes.—Carapax minutè pustulatus, marginibus lateralibus irregulariter paulo inciso-dentatis, rostro fere verticali, sub-polygonato, juxta antennam externam profundè constricto, apicem triangulatè emarginato, superficiem seriatim pustulato, pustulis setigeris. Oculi longè exserti. Pedes hirsuti.—Long. 7‴; lat. 6‴.‡ Long. rostri 3‴.

Hab. in mari ad insulam Tongatabu.

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* Vide Partem I, in Nuntiis Acad. Art. Sci. Amer., i, 149; Partem II, ibid. ii, 9; Partem III, ibid. ii, 201; Partem IV, hoc op. [2], viii, 424; Partem V, ibid. ix, 129.

† Vocabulum "Carapax," auctoritate antiquâ non munitum, scientia rogat; masculinum, voce *thorace* exemplo.

‡ Carapaci non corpori dimensiones referendæ.

Genus CHORILIA, *Dana.—Pisæ Chorino*que affinis. Carapax angustus, triangulatè ovatus, gibbosus, paulo armatus, rostro longo, furcato, cornubus gracilibus. Oculi in orbitis retractiles. Antennæ externæ sub rostrum celantes, articulo primo angusto, apicem externum acuto. Orbita infra interrupta, supra angustè unifissa, spinâ præorbitali acutâ. Pedes 1mi 2dis breviores, 8 postici similes, 2di 3tiis non multo longiores. *Pisâ* quoad antennas externas celatas differt; *Chorino* pedes 2dos 3tiis non multo longiores, 1mos 2dis breviores.

Chorilia longipes.—Carapax nec villosus nec pubescens, latitudine trans-orbitali perangustâ, triplo minore quam latitudo carapacis maxima, spinâ præorbitali tenui, acutâ, margine orbitali superiore angustè unifisso; rostro longo, pubescente, cornubus fere rectis, parce divaricatis; regione medianâ 4 spinis brevibus armatâ aliisque paucis brevissimis; regione cardiacâ parvâ, inermi, 2–4 tuberculis parvulis ornatâ; regione postero-laterali spinâ crassâ mediocri armatâ aliisque tuberculis parvulis ornatâ. Pedes antici longi, brachio trigono, margines spinuloso; carpo polygonato, margines spinuloso; manu subcarinatâ, subtilissimè tomentosâ.—Long. $1''$ $7'''$; lat. $10'''$.

Hab. ad oras Oregonenses.

Genus LAHAINA, *Dana.—Choriliæ* quoad pedes antennasque externas celatas affinis. Carapax elongatè ovatus, tumidus, parce armatus; rostri cornubus elongatis, gracillimis, divaricatis. Articulus antennarum externarum 1mus latus, parce longior quam latior, apicem processu spiniformi armatus. Orbita infra supraque sinu rotundato interrupta, dente præorbitali acuto. Pedes toti graciles.

Lahaina ovata.—Carapax vix spinosus, subvillosus, papillis postero-dorsalibus rectè flexis, spinâ postero-laterali parvulâ, aliâque posticâ; rostri cornubus corpore paulo brevioribus, tenuibus, valde divaricatis, margine orbitali superiore latè fisso, spinâ anticâ brevi acutâ et lateraliter unidentatâ, posticâ prominenter rectangulatâ non acutâ. Articulus antennarum externarum 1mus apicem spinigerus. Pedes tenues, longi, manu præangustâ, nudâ.

Hab. juxta insulam "Maui."

Genus SCYRA, *Dana.—Naxiæ* antennas orbitamque affinis. Rostrum laminatum, acutè furcatum. Articulus antennarum externarum primus undique angustus, apice externo ultra rostrum parce saliente; secundus depressus, tertio valde longior.

Scyra acutifrons.—Ovata, fere inermis, rostro brevi, cornubus ovato-lanceolatis, acutis, integris; spinâ præorbitali acutâ; regionibus carapacis valde prominentibus, regione medianâ aliisque profundè sejunctis, cardiacâ simpliciter rotundato-tuberculiformi. Pedes antici elongati, manu carinatâ, brachio angulos pustuloso, carpo 3–4-carinato.

Hab. in mari Oregonensi.

Genus CYCLAX, *D.—Mithraci* digitos affinis. Carapax suborbicularis, rostro parvulo, furcato. Oculi prælongi, retractiles, orbitis obliquè transversis. Antennæ externæ rostro remotæ, longæ, articulo primo apicem bi-spinoso, spinâ externâ longâ. Pedes longi; secundi carapace sesqui longiores; toti tenues, fere cylindrici.

Cyclax Perryi.—Carapax paulo oblongus, convexus, parce pustulatus, rostri cornubus subconicis, acutis, margine orbitæ superiore trispinoso, spinâ anteriore longiore et reflexâ, spinâ præorbitali parvulâ, post-orbitali crassiusculâ; marginibus carapacis antero-lateralibus 5-spinulosis, spinulis remotis, anteriore duplice; margine postico 2-spinuloso. Antennæ externæ dimidio carapacis longiores, pilosæ. Pedes carapace valde longiores, 8 posticis sparsim pilosis, tarso infra paulo piloso.—Long. $2\frac{1}{2}'''$.

Hab. in mari Vitiensi.

Eurypodius septentrionalis.—Carapax obsoletè villosus, spinis paucis, in regione cardiacâ posterius duabus anterius unâ; spinâ post-orbitali acutâ et anteriore minori vel acutâ vel obtusâ; rostro supra complanato. Articulus antennarum externarum 1mus dente subacuto extus ad basin armatus et juxta dentem processu subacuto. Pedes toti fere nudi; antici crassiusculi, brachio carpoque parce tuberculato-spinosis, manu scabro-granulatâ, paulo tumidâ, digito cum dente parvulo tuberculiformi intus armato polliceque juxta basin cum dente simili. Pedes 8 postici longi, articulo pedis tertii tertio tuberculis setiferis parvulis biseriatis infra ornato, 5to longiore quam quartus, subtilissimé hirsuto, ejus margine inferiore versus apicem brevissimè hirsuto.—Long. $2''$ $7\frac{1}{2}'''$; rostri $7\frac{1}{2}'''$; pedis secundi carapace plus duplo major.

Hab. in portu "Nassau" Fuegiæ.

Eurypodius brevipes.—*Feminæ*:—Carapax valde tumidus, spinis paucis, brevibus, in regione cardiacâ posterius duâbus anterius unâ; rostro supra complanato, breviore. Articulus antennarum ext. 1mus extus ad basin dente armatus et juxta dentem processu subacuto. Pedes breves, hirsuti, primi subtenues, brachio carpoque cum 3–4ve tuberculos minutos supra armatis, manu lineari, tenui, lævi, margine digiti interno denticulato. Pedes octo postici crassiusculi, valde breviores, articulo 3tio pedis secundi valde breviore quam carapax, articulo 5to lato et crasso, longiore quam quartus, non duplo longiore quam tarsus.—Long. $1''$ $7\frac{1}{2}'''$; rostri $3\frac{1}{2}'''$; coxæ pedis secundi $1''$, articuli 5ti $8'''$ ejusque lat. $2\frac{1}{2}'''$; tarsi $5\frac{1}{3}'''$.

Hab. in portu "Nassau" Fuegiæ.

Genus OREGONIA, *Dana*.—Rostrum, antennas, oculos, spinam postorbitalem pedesque elongatos *Eurypodio* affinis. Pedes tenues, octo postici articulum quintum aliosque subcylindrici, nunquam compressi.

Oregonia gracilis.—Carapax breviter sparsimque pubescens, rostro valde longiore quam latitudo inter-orbitalis. Pedes breviter sparsimque pubescentes, tenues; primi secundis paulo breviores, brachio tuberculis minutis supra infraque ornato, manu fere lineari, digito intus prope basin unidentato alioque denticulato. Abdomen *maris* sublineare, margine laterali versus apicem excavato, apice truncato.—Long. $1''$ $7'''$.

Hab. in maris Oregonensis freto "Puget."

Oregonia hirta.—Carapax pedesque sparsim hirti, rostro tenui, breviore quam latitudo inter-orbitalis. Pedes paulo breviores; digito pedis antici intus æque denticulato.—Long. $1''$ $5'''$.

Hab. in maris Oregonensis freto "Puget."

PERICERA TRIGONA.—Carapax bene triangulatus, triangulo equilaterali, spinâ postero-laterali longâ, crassâ, complanatâ; spinis dorsalibus duobus, unâ medianâ, alterâ cardiacâ; rostro mediocri, cornubus divergentibus; spinâ præorbitali perbrevi, subacutâ. Regio pterygostomiana uni-spinosa. Articulus pedum 3tius minutè tuberculatus et apicem plerumque spinoso-productus; manu tenui, digitis omnino contiguis.—Long. $1\frac{1}{4}''$.

Hab. in mari Vitiensi.

Genus TIARINIA, *Dana.*—*Periceræ* orbitam antennasque affinis. Rostrum bifidum, cornubus plerumque contiguis. Carapax subpyriformis, tuberculatus aut pustulatus, tuberculo cardiaco tuberculis tribus aut pluribus facto. Articulus antennarum ext. 1mus latissimus, spinâ apicali non armatus, angulo externo-apicali interdum paulo saliente et subacuto. Orbita bene tubulata. Spina præorbitalis prominens. Pedes 1mi 2dis non longiores.—*Pericerâ*, cornubus rostri fere contiguis, formâ carapacis, et superficie aggregato-tuberculosâ, differt *Pericera tiarata* hìc pertinet.

TIARINIA GRACILIS.—Carapax pone oculos paulo constrictus, latitudine carapacis maximâ longitudinem post-orbitalem fere æquante, latitudine trans-orbitali sat majore quam dimidium latitudinis maximæ; rostro antennis externis breviore, cornubus apicem parce divergentibus, lateribus non dentigeris. Antennæ externæ ciliatæ, articulo primo angulum externum producto, subacuto, articulis secundo tertioque angustis, ad apicem parce latioribus. Manus tenuis, digitis omnino contiguis. Pedes 8 postici sparsim pubescentes, articulo tertio plus minusve tuberculato.—Long. $6'''$; lat. $3'''$.

Hab. in mari Suluensi.

TIARINIA ANGUSTA.—Carapax angustior, pone oculos vix constrictus, latitudine maximâ multo breviore quam longitudo post-orbitalis, latitudine trans-orbitali parce minore quam latitudo maxima; rostro longo, cornubus apicem conspicuè divergentibus, lateribus cum 3–4 dentes minutos remotos armatis. Antennæ externæ rostro dimidio breviores, articulis 2do 3tioque tenuibus. Manus tenuis, digitis omnino contiguis. Pedes 8 postici pubescentes, secundi 3tiis duplo longiores. Articulus 3tius paris antici plus minusve tuberculatus.—Long. $6'''$; rostri $2'''$; lat. $2\frac{1}{2}'''$.

Hab. in mari Suluensi.

Genus PERINIA, *Dana.*—*Periceræ* affinis. Orbita anticè paulo aperta eoque non bene tubulata, margine superiore non unifisso. Articulus antennarum ext. 1mus oblongus, anticè non latior, apicem externum paulo productus. Rostrum breviusculum, cornubus divaricatis. Carapax tumidus, paucis tuberculis tumidis ornatus.

PERINIA TUMIDA.—Carapax valde tumidus, brevis (lat. maximâ long. post-rostralem æquante) lateribus rotundatis, regione medianâ convexâ minutè bi-tuberculatâ, regione cardiacâ largè tuberculiformi, laterali tumidè tri-tuberculatâ. Rostrum breve, latitudine trans-orbitali fere duplo brevius. Spina præ-orbitalis brevis, subacuta. Pedes breves, articulis 3tio 4toque spinosè tuberculatis, manu crassâ, digitis latissimè hiantibus, digito mobili prope basin unidentato.—Long. $3\frac{1}{2}'''$; lat. plus $3'''$.

Hab. in mari juxta insulam Hawaiiensem "Maui."

MENÆTHIUS ANGUSTUS.—Carapax sat tuberculatus, perangustus (latitudine multo minore quam longitudo post-rostralis), dentibus lateralibus tribus, duobus anticis bilobatis; rostro longo, emarginato; regione medianâ tumidâ, posticè bituberculatâ et anterius areâ triangulatâ notatâ; regione post-medianâ brevi, uni-tuberculatâ; regione intestinali grandi unituberculatâ, margine postico rotundato, integro.—Long. $5\frac{1}{2}'''$; lat. $3'''$.

MENÆTHIUS AREOLATUS.—*M. subserrato* affinis. Carapax paulo tuberculatus, tuberculo cardiaco simplice, quoque post-mediano intestinalique simplicibus; rostro integro, mediocri, margine laterali dentibus tribus, primo simplice, secundo paulo duplice. Oculi apicem rotundati et spinâ anticâ alterâque posticâ instructi. Manus oblonga, superficie subtilissimè areolata, digitis plerumque contiguis, denticulis sex. Pedes 2di 1mis longiores.—Long. $2'''$.

Hab. in mari Suluensi.

MENÆTHIUS INORNATUS.—Carapax latus, latitudine trans-orbitali dimidio minore quam sive latitudo maxima sive longitudo post-rostralis, pone oculos non constrictus; marginibus lateralibus 3-dentatis, dentibus triangulatis subacutis; rostro brevi, integro; spinâ præorbitali latè triangulatâ; superficie dorsali paululum gibbosâ, regione cardiacâ simplicissimè tuberculatâ, medianâ tumidâ, vix subdivisâ, regione laterali fere planâ. Oculi parce salientes, apicem bene truncati.—Long. $5'''$; rostri $1'''$; lat. $4'''$.

Hab. in mari juxta insulam Hawaiensem "Maui."

ACANTHONYX SIMPLEX.—*Feminæ: A. Petiverio* affinis. Carapax parce convexus, tuberculis omnino carens, marginibus lateralibus parallelis, posterius cum dentibus duobus obsoletis ornatis, dente post-orbitali nullo. Pedes antici reliquis parce crassiores, digitis plerumque contiguis, 7–8-denticulatis, denticulis triangulatis, carpo supra cristato, subacuto; paris postici articulus penultimus angustior, angulo inferiore basi nec apici propiore, (in *Petiverio* apici nec basi propiore). Tarsus 8–10 spinulis armatus.—Long. $9'''$; lat. $5\frac{2}{3}'''$.

Hab. ad insulas Hawaienses.

ACANTHONYX DEBILIS.—*Petiverio* affinis. Carapax paulo convexus, marginibus lateralibus parallelis, regione medianâ obsoletè bi-tuberculatâ, tuberculis setigeris. Pedes antici *maris* reliquis vix crassiores. Digitis parce hiantibus, carpo non cristato. Tarsus pedis postici 12–14 spinulis seriatim armatus; articulus penultimus latè triangulatus, infra obliquè truncatus.—Long $9'''$; lat. $5\frac{2}{3}'''$.

Hab. ad oras Chilenses.

Genus PELTINIA, *Dana.—Epialto Acanthonyci*que affinis. Carapax latus, sublævis, depressus, rostro brevi complanato, profundè bifido, latitudine transorbitali grandi, quam dimidium carapacis vix angustiore, dente præorbitali prominente, antero-laterali valde producto, postero-laterali parce prominente. Antennæ externæ rostro non celatæ, articulo primo angusto, apicem non dentigero. Oculi non retractiles, breves. Pedes 1mi 2dis breviores. Articulus 8 pedum posticorum penultimus fere cylindricus infraque non gibbosus.—Antennis apertis Epialto differt, Acanthonyce congruit; articulo pedum 8 posticorum penultimo subcylindrico Acanthonyce differt. Latitudo transorbitalis Antilibiniæ latitudine duplo major; quoque dorsum depressum, rostrum profundius furcatum.

PELTINIA SCUTIFORMIS.—Carapax subscutiformis, paulo oblongus, lævis, rostro vix longiore quam latiore, bilobato, angulis antico-lateralibus valde productis setigeris, diametroque gastrico maximo. Margine postero-laterali dentibus duobus obsolescentibus setigeris notato, regione mediană bi-tuberculată. Antennæ externæ rostro valde longiores. Pedes tenues, antici inermes, digitis contiguis.—Long. 2‴.

Hab. in portu "Rio Janeiro."

PELTINIA NODULOSA.—Carapax suboctagonus, parce oblongus, lævis, angulis duobus lateralibus utrinque productis, obtusis, rostri cornubus triangulatè sejunctis, triangulatis, subacutis; dente præorbitali subacuto, post-orbitali obsoleto, margine postico inermi. Pedes nudi, mediocres, articulis totis manu tarsoque exceptis, plus minusve nodulosis, tarsis infra minutè spinulosis. Antennæ externæ apicem rostri parce superantes.—Long. 3‴.

Hab. in mari Vitiensi.

HALIMUS TUMIDUS.—Rostri cornua subconica, latè divaricata. Carapax valde tumidus, latere 4–6 spinulis minutis armato; regione mediană tribus tuberculis parvulis triangulatè ornată, alio tuberculo obsolescente posteriore; regione cardiacă tuberculis obsolescentibus notată. Pedes pubescentes, sat breves; manu tenui, basin latiore, digitis fere contiguis, tenuibus; articulo 5to pedis postici duplo longiore quam latiore. Articulus antennarum ext. 1mus apicem externum valde productus extusque 2–3-spinulosus.—Long. 7‴.

Hab. ad oras Australiæ orientalis.

HUENIA SIMPLEX.—*Maris:*—Carapax lævis, valde elongatus, angustè subtriangularis, lateribus antero-lateralibus longis, anticè convergentibus fere rectis et integris, in latera rostri rectè productis, dente præorbitali nullo, rostro oblongo, valde obtuso, angulo postero-laterali subacuto; margine postico integro; superficie 4-tuberculată, (regione mediană 3-tuberculată, cardiacă 1-tuberculată.) Pedes antici validi, manu crassă, digitis latissimè hiantibus; articulus pedum 8 posticorum penultimus subcylindricus.—Long. 9½‴.

Hab. ad Insulas Hawaienses.

HUENIA BREVIROSTRATA.—*Feminæ:*—Carapax latus, paulo oblongus, breviter rostratus, utrinque 2-angulatus, angulis salientibus, lateribus inter angulos laterales valde excavatis; superficie carapacis breviter 4-tuberculată, rostro ad basin valde angustiore quam frons, acuto, non longiore quam latitudo transorbitalis, dente præorbitali vix saliente, obtuso. Manus tenuis, digitis versus basin paulo hiantibus, carpo inermi; articulus pedum 8 posticorum penultimus subcylindricus.—Long. 7½‴.

Hab. ad Insulas Hawaienses.

LEUCIPPA LÆVIS.—Carapax subtriangulatus, lævis, regione mediană parce tumidă, rostro elongato, furcato, cornubus triangulatis, et triangulatè sejunctis, acutis; marginibus carapacis lateralibus pertenuibus, paulo expansis et subreflexis, 4-dentatis (aut angulatè undulatis), dentibus inæquis, dente posteriore posticè arcuato, hoc margine in superficiem regionis postero-lateralis producto. Regio pterygostomiana 3-dentata (aut instructa uno dente in sinu grandi insito). Pedes nudi, articulo 3tio cristato.

LAMBRUS RHOMBICUS.—Carapax paulo transversus, medium latior, subrhombicus, lateraliter posticèque arcuatus, pone oculos non constrictus; superficie inæquali tuberculis parvulis parce ornatâ, regione laterali super basin pedis secundi tuberculo conico armatâ, posterius altero minore; rostro apicem pubescente. Pedes antici margines hirsuti, manu trigonâ, marginibus salientibus inæque dentatis, brachio marginem anticum minutè eroso et superficiem minutè spinuloso. Pedes 8 postici gracillimi, breviter pubescentes.—Long. 10″.

Hab. in Archipelago Vitiensi, mari Pacifico.

CERATOCARCINUS? SPECIOSUS.—Carapax hexagonus, fere equilateralis, depressus, regionibus partim conspicuis, fronte lato, rectè transverso, subtiliter crenulato, medium emarginato, utrinque juxta oculum valde saliente. Manus digitusque mobilis spinulosi; carpus parce spinulosus; digiti contigui. Pedes 8 postici breviter pubescentes, inermes. —Long. $1\frac{1}{2}'''$.

Hab. in Archipelago Vitiensi, mari Pacifico.

2. *Zoological Researches;* by JOSEPH LEIDY, M.D. 1850.

(1.) *On American Annelida abranchiata*, (Jour. Acad. Nat. Sci., ii, 43.)—This memoir contains descriptions of the following species from the vicinity of Philadelphia.

Nais rivulosa.	Enchytræus vermicularis, *Henle.*
Nais gracilis.	Enchytræus socialis.
Pristina longiseta, *Ehrenb.*	Lumbriculus limosus.
Strephuris (*Leidy*) agilis.	Leucophrys clavata.
Aeolosoma venustum.	

The new genus *Strephuris*, is described as follows:—Podal spines alternating with setæ, in two rows. Upper lip moderately projecting. Girdle well marked. Number of articulations not over seventy. No muscular stomach. Blood bright red.

The paper is accompanied with a lithographic plate illustrating with details the species described.

(2.) *On two New Genera of Fossil Mammalia*, (Proc. Acad. Nat. Sci., Philad., v, 90.)—The species are named *Eucrotaphus Jacksoni* and *Archæotherium Mortoni;* they are from the vicinity of Fort Laramie.

(3.) *Contributions to Helminthology*, (Proc. Acad. Nat. Sci. Philad., v, 96.)—The species here described are—

Ligula Tritonis.	Echinorhynchus ovatus.
Pentastomum Didelphidis Virginianæ.	Echinorhynchus tortuosus.
Pentastomum Euryzonum, *Diesing.*	Echinorhynchus Pici collaris.
Pentastomum proboscideum, *Rud.*	

(4.) *Notes on the development of the Gordius aquaticus*, (Proc. Acad. Nat. Sci., v, 98, Oct., 1850.)

(5.) *Two new species of Infusorial Entozoa*, (Ib., p. 100.)—The species are *Nyctotherus ovalis* and *Bodo Julidis.*

(6.) *Description of some Nematoid Entozoa infesting Insects*, (Ib., p. 100.)—Species:

Streptostoma gracile.	Thelastoma robustum.
Thelastoma appendiculatum.	Oxyuris socialis.
Thelastoma labiatum.	Hystrignathus rigidus.

(7.) *Descriptions of three Filariæ*, (Ib., p. 117.)—Species:—Filaria Hominis oris, F. canis cordis, F. Boæ constrictoris.

(8.) *On the nettling organs of the Hydra*, (Ib., p. 119.)

(9.) *New Fossil Mammalia from Missouri*, (Ib., p. 121.)—Species:—Palæotherium Bairdii, Rhinoceros nebraskensis, Merycoidodon Culbertsonii, Agriochœrus antiquus.

The species of Palæotherium described in this Journal, vol. iii, p. 248, 2nd Ser., is called P. Proutii.

(10.) *New Species of Vermes*, (Ib., 124.)—Species:—

Peloscolex (*Leidy*) variegatus. Emea (*Leidy*) rubra.
Chætogaster gulosus. Anortha (*Leidy*) gracilis.
Rhynchoscolex (*Leidy*) simplex.

3. *Value of the word Species in Zoology;* by S. G. Morton, M.D., (Proc. Acad. Nat. Sci., Sept. 10, 1850, v, 81.)—On the value of the word *species*, there is great diversity of opinion among naturalists. Some deny the law of specific distinctions—at least their arguments lead to this inference. Thus, Lamarck and Geoffroy St. Hilaire insist upon the uninterrupted succession of the animal kingdom—the gradual mergence of one species into another, from the earliest ages of time: and they suppose that the fossil animals whose remains are preserved in the various geological strata, however different from those of our time, may nevertheless have been the ancestors of those now in being. Sir Charles Lyell has opposed this theory with great ingenuity and general success; yet whoever will examine the facts and arguments employed by its authors, may be disposed to admit that it is not altogether devoid of foundation in some exceptions to the general law of Nature.

Somewhat allied to this is the opinion of Swainson and others, that permanent varieties constitute species, or in other words, that variations of climate, food and treatment produce specific distinctions.

Species is defined by Buffon, "a succession of similar individuals which re-produce each other." Cuvier's definition is nearly the same; but he adds that "the apparent differences between the races of our domestic species are stronger than those of any species of the same genus. The fact of the *succession*, therefore, and of the constant succession, constitutes alone the validity of the species."

An objection to these definitions arises from the fact that they apply as readily to mere varieties as to acknowledged species. Certain albino animals re-produce, *inter se*, to an indefinite extent; such also is the case with some fanciful varieties of the dog, pigeon, &c., which are capable of multiplying by the law of succession, and yet have no claim to specific distinction, in the restricted acceptation of that term.

I have brought together these definitions, in the first place to show that naturalists are by no means agreed upon what constitutes a species, and secondly, to offer some views of my own.

As the result of much observation and reflection, I now submit a definition which I hope will obviate at least some of the objections to which I have alluded. Species—*a primordial organic form.* It will be justly remarked that a difficulty presents itself, at the outset, in determining what forms are primordial; but independently of various other sources of evidence, we may be assisted in the inquiry by those monumental records, both of Egypt and Assyria, of which we are now happily possessed of the proximate dates. My view may be briefly explained by saying, that if certain existing organic types can be traced back into the "night of time," as dissimilar as we see them now, is it

not more reasonable to regard them as aboriginal, than to suppose them the mere accidental derivations of an isolated patriarchal stem of which we know nothing? Hence, for example, I believe the dog family not to have originated from one primitive form, but from many. Again, what I call a species may be regarded by some naturalists as a *primitive variety*; but, as the difference is only in name, and in no way influences the zoological question, it is unnecessary to notice it further.

These views appear to correspond with those of Mr. Linnæus Martin, who expresses himself in the following terms:

"We are among those who believe that, as there are degrees in the relationship of species to species, some may, although distinct, approximate so nearly as not only to produce *inter se*, mules incapable of interbreeding, but *a progeny of fertile hybrids, capable of admixture, even to the most unlimited extent?*

Species may therefore be classed according to their disparity or affinity, in the following provisional manner:

Remote species of the same genus, are those among which hybrids are never produced.

Allied species produce, *inter se*, an infertile offspring.

Proximate species produce with each other a fertile offspring.

IV. Astronomy.

1. *The new planet Egeria*, (Gould's Astron. Jour., No. 21.)—This planet was discovered by Mr. Gasparis of Naples in Italy, on the 2d of Nov. 1850. The discoverer having requested M. Le Verrier to name the planet, the latter has proposed to designate it *Egeria*, which name will of course be adopted. The body resembled a star of the 9th or 10th magnitude, and belongs to the group between Mars and Jupiter. The following elements of its orbit are by M. G. Rümker.

1850, November	2·0 Greenwich, m. t.	
Mean longitude,	288° 37′ 17″·0	
Long. of perihelion,	116 26 49 ·4	m. Eqx. 1851.
" " Asc. node,	43 35 24 ·4	
Inclination,	15 57 59 ·8	
Angle of excentricity,	5 31 9 ·38	
Log. semi axis major,	0·4082517	
Log. of mean daily motion,	2·9376290	

V. Miscellaneous Intelligence.

1. *Magnetism;* (Proc. Roy. Soc., Dec., 1850; Athenænm, No. 1206.)—The Bakerian Lecture was delivered by M. Faraday, Esq., illustrated by experiments. After alluding to the experiments of Padre Bancalari, the lecturer showed the opposite magnetic condition of oxygen and nitrogen; the former when inclosed in a bubble of glass is always attracted by the magnet, the latter repelled. In common with iron and some other metals, oxygen loses its magnetism on the application of heat, and regains it on again becoming cold. In this fact Mr. Faraday finds the cause of the diurnal movements of the magnetic needles all over the world, as exhibited at the respective observatories; and he

explains the apparent anomalies which occur at St. Helena and Singapore on the hypothesis induced from the whole of the phenomena. The lecturer, in closing, stated that the explanation was to be received as conjectural, although, at present, sufficiently satisfying the theory.

2. *A comparative examination of the objective glasses of Microscopes from Mr. Ross of England, Mr. Spencer of America, and M. Nachez of Paris;* by J. LAWRENCE SMITH, (communicated for this Journal.)—Having had an opportunity a short time since, while at Paris, to examine the comparative merit of the lenses of these makers, it might not be uninteresting to microscopists to know the result of my examination, particularly as it was made under peculiar circumstances; namely, by adapting alternately the objectives to the same mounting, and regarding the same object under the same illumination.

The glasses used were considered by their makers as among their best. That made by Ross was in the possession of M. Rutherford of U. S. Spencer's was owned by Dr. Burnet of Boston, and had just been brought by him from Spencer. That of Nachez belong to Dr. Bigelow of Boston, now in Europe engaged in microscopic research very creditable to himself. Their magnifying powers varied from thirteen hundred to fifteen hundred diameters, with an ocular magnifying ten times; Ross's was the feeblest, that of Spencer the strongest.

The angular opening was first measured with great accuracy and found as follows:—

Ross, ...	145°
Spencer, ...	135°
Nachez, ...	120°

These measurements were all verified by the respective owners of these lenses.

The objects examined were the most difficult test-objects among the siliceous infusoria, as the Navicula angulata, one of the species of Gramatophora, and a Navicula called the Amici test. The first two were in balsam.

The lenses were first attached to one of Nachez's mounting, and the best adjustment of oblique light used that this instrument affords. The difference in the effect of the three lenses was very slight, all failing to show the lines on the Gramatophora or on the Amici test. As notwithstanding the admirable arrangement of Nachez's instrument for working purpose, we do not get the extreme obliquity of light which is required for examining their fine lines, I had them all arranged on a mounting of Amici, which furnishes the necessary obliquity of light. Thus arranged, the lines on the Gramatophora were distinctly and beautifully seen by all, with slight advantages in favor of Spencer and Ross, the former of which magnified them most.

The Amici test was next tried which resulted in Ross showing the lines with perfect satisfaction; Spencer showing them, but not quite so well; Nachez still less distinctly.

I would remark that this difference between the lenses appears to be owing entirely to difference in the angle of opening, for where a very oblique light is necessary to show lines, the lenses must be so constructed as to admit this light. I would also state that Nachez's system

lacks an adjustment which the others have, by which the relative position of the lenses can be changed, so as to compensate for the thickness of the glass which covers the object, and which appears favorable to the examination of those delicate tests. For the examination of globules we could not perceive any appreciable difference between the lenses.

I would here remark in justice to M. Nachez that he deserves much praise for the manner in which he has improved the microscope in France, without augmenting the cost of the instrument, and out of England he is undoubtedly the best maker in Europe. To furnish an idea of what he has done to diminish the cost of a good instrument, I will compare the price of the objectives which have been the subject of the experiments.

Ross, ...	306 francs.
Spencer, ...	230 "
Nachez, ...	60 "

and what is still more, he is constantly improving his lenses without adding to their expense.

The lower powers of these makers were examined, without finding any sensible difference in the defining effects of them, and what little there was, was in favor of Spencer. The field of the three differed, Nachez's being the least, and Spencer's the greatest. We cannot bestow too much praise on our American maker, for the immense progress which he has made in the construction of objective lenses, and it is to be regretted that he has not chosen a better mounting for them, than that of Chevalier, which is very defective and prevents good glasses from showing their best effects.

I had intended making some remarks on oblique light, which has come very much in use lately in observing lines and points on certain objects, but it will be better for me to defer it. I would simply remark that much caution is necessary in using it, as it will not always give correct distances between lines.

3. *Logeman's Magnets.*—As the magnets of W. M. Logeman are remarkable for their power, we insert here a list of his prices, received from him in a letter dated Haarlem, Sept. 22, 1850.—Eds.

A list of the prices of my magnets was published some months ago by Prof. Poggendorff at Berlin in his Annalen der Physik und Chemie. They are as follows:

No.	Force of attraction in Prussian pounds.	Price in florins.	No.	Force of attraction in Prussian pounds.	Price in florins.
1.	25	10	5.	150	95
2.	40	17	6.	200	128
3.	80	42	7.	300	170
4.	120	78	8.	400	240

A Prussian pound is equal to 1·031 English pounds, and two Dutch florins are equivalent to one dollar. Straight bars of every size for magnetical observations, of the same relative force as the above horse shoe magnets, are afforded at very moderate prices.

A horse shoe magnet of 500 pounds force can be made at a price but little higher than one of 400 pounds, at least, it will not cost above three hundred florins.

The forces of attraction given above are the *constant* forces of the magnets, which will not diminish by repeatedly and abruptly forcing the armature from the poles.

4. *Albuminizing Photogenic Glasses*, (Athenæum, No. 1205.)—We have received from Dr. Maunoir a translation, made at the request of M. Scarpellini—the President of a Society having its meetings on the Capitol, called *Romana Corrispondenza Scientifica*,—of a paper published in the Society's Journal by M. Luigi Ceselli, on a new process for "albuminizing photogenic glasses." It appears to point out a method by which extreme uniformity in the thickness of the film may be obtained:—and we print it from Dr. Maunoir's manuscript, with a few verbal alterations where there appears to be a want of clearness, arising from the difficulty which a foreigner writing in English must necessarily experience when not thoroughly familiarized with the idiom of the language.

It cannot be denied that photography has gained much by the substitution of glass for photogenic paper; as thus has been obtained a high degree of transparency of the plates for the process, a modification of that applied by Daguerre to the grand discovery of the celebrated Neapolitan, Gio. Batt. Porta, which discovery remained forgotten for nearly two centuries. Many difficulties, however, still existed; for, with the use of glass, a layer of albumen was necessary to the production of those wonderful results obtained by the rays of light. Again, to cover the glass with a layer of albumen of equable thickness, so that the light may produce everywhere the same effect, to prevent any inequalities forming on the surface during the drying process, to produce the layer at one stroke,—such were the difficulties which, notwithstanding repeated experiments, yet remained to be overcome and had retarded the progress of this wonderful new method,—but which, it seemed to M. L. Ceselli, did not deserve to be abandoned, to be replaced by the improvements obtained with photogenic paper.

After having studied the various processes in use, M. L. Ceselli invented a small simple machine, which he has found to obviate every difficulty.

It consists of a small rectangular box, supported by three regulating screws. To its base is joined a moveable plate of metal, which, being heated by means of a lamp of alcohol, communicates to all parts of the box an equal degree of heat. The plate is removed when the water-bath is to be used instead of the lamp. The apparatus is protected by a glass covering, to guard against heterogeneous bodies falling on the albumen. This cover is also moveable; and the box being traversed by an internal channel, in this, when convenient, a thermometer may be introduced. A sliding frame receives the glass which is to receive the preparation; this, again, being placed between two other plates of glass. The glasses are secured and their edges brought to correspond by means of a tightening screw,—so that the albumen, when either spreading or shrinking, may always cover the whole surface of the intermedial plate of glass. The frame is furnished on two parallel sides with a small groove to receive the albumen,—which a small round edged knife, elevated to the proper point by means of two spiral pivots cased in the sides of the box, and kept down in a parallel

direction to the glass by means of a screw, serves to remove, producing by this means the exact thickness of layer which is required. The frame is furnished along one of its sides with an indented ridge, to which a wheel provided with an external handle corresponds, so that the frame can be made to move with such velocity as the operation may require.

5. *New Method of Engraving Plates for Printing Ferns, Sea Weeds, &c.*, (Athenæum, No. 1207.)—At a recent meeting of the Sheffield Literary and Philosophical Society, Dr. Branson read a paper describing this process.—His mode of operation is to place a frond of fern, alga, or similar flat vegetable form, on a thick piece of glass or polished marble; then taking and softening a piece of gutta percha, of proper size, and placing on the leaf and pressing it carefully down, it will receive a sharp and accurate impression from the plant. The gutta percha retained level, and allowed to harden by cooling, is then handed to a brass caster, who reproduces it in metal from his moulding vase. This, it will be obvious, is the most delicate and difficult part of the process, and one which, a few years ago, would not, we suspect, have been executed in Sheffield. As it is, Dr. Branson has had many brass plates thus produced from sand-casting, which required only a little surface-dressing to yield, at once, under the copper-plate printing-press, most beautiful as well as faithful impressions of the original leaves: indeed, many of the exhibited specimens of ferns, printed in green color, and slightly embossed, as they must needs be by the printing, were such perfect fac-similes of the natural pattern, that they might easily be taken for it. Besides these matters, the doctor exhibited a large variety of patterns of embossed leather, which had been produced by a somewhat analogous operation. As, however, this latter invention is not so much for copying designs as for creating them, and at the same time, saving all the expense of die-cutting, the following is the course pursued:—The operator takes a piece of common hard white soap of the required size and surface, and upon that executes any design, whether of the depth and boldness of ordinary embossing or in the delicate lines of an etching; in either case the work is executed with the greatest ease. From this soap-model or engraving, an impression is taken in gutta percha; from *that* a secondary one, which on being cast in brass, as before, may be used for printing or embossing in the ordinary way. The reader stated that his main difficulty was in getting the last gutta percha coat to separate from the mould of the same substance into which it was pressed. He had found, however, that by powdering both the surfaces with common bronze dust, before taking the impression, they did not adhere.

6. *On Sugar in the flowers of Rhododendron ponticum.*—Prof. George Jæger of Stuttgardt writes us that the existence of cane sugar in the flowers of the Rhododendron ponticum, announced as ascertained by Dr. B. Shlamer in volume x, p. 113 of this Journal, was first determined by him and published in the year 1825 in the Zeitschrift für Physiologie von Tiedemann and Treviranus, vol. xi, p. 173, and is cited from him by Gmelin in the third edition of his Hand-book of Chemistry, vol. ii, p. 733.—Eds.

7 *On British Eocene Serpents and the Serpent of the Bible;* by Professor OWEN, (Jameson's J., xlix, 239, from Owen's British Reptiles.) —A few bones of serpents have been found in the superficial stalagmite, and in clefts of caves, in peat bogs, and the like localities, which bring their occurrence and deposition within the period of human history. None of these Ophidian remains, however, have offered any differences in size or other characters from the corresponding parts of the skeleton of our common harmless snake (*Coluber natrix*). As yet, no Ophidian fossils have been found in British fresh-water formations of the pre-adamitic or pleistocene period, from which formations the remains of the Mammoth, Tichorrhine Rhinoceros, great Hippopotamus, and other extinct species of existing genera of *Mammalia* have been so abundantly obtained. Between the newest and the oldest deposits of the tertiary period in geology, there is a great gap in England, the middle or miocene formations being very incompletely represented by some confused and dubious parts of the crag of fluvio-marine origin in which teeth of a mastodon have been found.

The deposits in which the remains of the large serpents of the genus *Palæophis* occur so abundantly, carry back the date of their existence to a period much more remote from that at which human history commences. Yet, as the strange and gigantic reptiles that have been restored, and, as it were, called again to life, from times vastly more ancient, realize, in some measure the fabulous dragons of mediæval romance; so the locality on our shore of the English channel in which the Eocene serpents have been found in most abundance and of largest size, recalls to mind, by a similar coincidence, the passage cited by an accomplished and popular historian, in his masterly sketch of the rise and progress of the English nation. "There was one province of our island in which, as Procopius had been told, the ground was covered with serpents, and the air was such that no man could inhale it and live. To this desolate region the spirits of the departed were ferried over from the land of Franks at midnight."*

The discovery of serpents of different genera and species, some, as *Paleryx*, terrestrial, and all manifesting the peculiar and characteristic vertebral organization of true *Ophidia*, at a period incalculably remote from that at which we have any evidence of the existence of man, more forcibly recalls our early ideas of the nature and origin of serpents derived from annotations to Scripture which represented them as the progeny of a transmuted species, degraded from its originally created form as the consequence and punishment of its instrumentality in the temptation of Eve.

"The curse upon the serpent," say the learned Drs. D'Oyly and Mant, in the edition of the Bible printed under the direction of the Society for the promotion of Christian Knowledge, ed. 1823, "consisted, 1*st*, in bringing down his stature, which was probably, in great measure, *erect* before this time; 'upon thy belly shalt thou go,' or, 'upon thy breast,' as some versions have it: 2*dly*, In the meanness of his provision, 'and dust shalt thou eat,' insomuch as creeping upon the ground, it cannot but lick up much dust together with its food."

* Macaulay's History of England, vol. i, p. 5.

The idea of the special degradation of the serpent to its actual form, derived from interpreting the sentence upon it as a literal statement of fact, has been so prevalent as to have affected some of the zoological treatises of the last century. Thus, in the quaint and learned "Natural History of Serpents," by Charles Owen, D.D., 4to, 1742, p. 12, the author, treating of the food of those reptiles, writes,—"That dust was not the original food of the serpent seems evident from the sentence passed upon the Paradisaic serpent, but the necessary consequence of the change made in the manner of its motion, *i. e.*, the prone posture of its body, by which it is doomed to live upon food intermixed with earth."

Dr. Adam Clark, commenting more recently upon the record in its literal sense, seeks to elude the difficulties which thence arise, by contending that the Hebrew "Nachash," may be translated "Ape," as well as "Serpent." But when we find him reduced to the necessity of glossing the text by such expositions, as that to go on the belly, means "on all fours;" and by affirming, of the arboreal frugivorous four-handed monkeys, that "they are obliged to gather their food from the ground," we have a lively instance of the straits to which the commentator is reduced who attempts to penetrate deeper than the Word warrants, into the nature of that mysterious beginning of crime and punishment, by the dim light of an imperfect and second-hand knowledge of the divine works.

If, indeed, the laws of the science of Animated Nature formed part of the preliminary studies of the theologist, the futility of such attempts to expound the third chapter of Genesis, viewed as a simple narration of facts, would be better appreciated by him; and if he should still be prompted to append his thoughts, as so many lamps by the side of the second text, he would most probably restrict himself to the attempt to elucidate its symbolical signification.

What zoology and anatomy have unfolded of the nature of serpents in regard to their present condition, amounts to this:—that their parts are as exquisitely adjusted to the form of their whole, and to their habits and sphere of life, as is the organization of any animal which, in the terms of absolute comparison, we call superior to them. It is true, the serpent has no limbs, yet it can outclimb the monkey, outswim the fish, outleap the jerboa, and, suddenly loosing the close coils of its crouching spiral, it can spring into the air and seize the bird upon the wing; thus all these creatures fall its prey. The serpent has neither hands nor talons, yet it can outwrestle the athlete, and crush the tiger in the embrace of its ponderous overlapping folds. Far from licking up its food as it glides along, the serpent lifts up its crushed prey, and presents it, grasped in the death-coil as in the hand, to the gaping slime-dropping mouth.

It is truly wonderful to see the work of hands, feet, fins, performed by a simple modification of the vertebral column in a multiplication of its joints, with mobility of its ribs. But the vertebræ are specially modified, as I have already described, to compensate, by the strength of their individual articulations, for the weakness of their manifold repetition and of the consequent elongation of the slender column.

As serpents move chiefly on the surface of the earth, their danger is greater from pressure and blows from above; all the joints are accordingly fashioned to resist yielding, and to sustain pressure in a vertical direction; there is no natural undulation of the body upwards and downwards, it is permitted only from side to side. So closely and compactly do the ten pairs of joints between each of the two or three hundred vertebræ fit together, that even in the relaxed and dead state the body cannot be twisted, except in a series of side coils.

Of this the reader may assure himself by a simple experiment on a dead and supple snake. Let him lay it straight along a level surface; seize the end of the tail, and, by a movement of rotation between the thumb and finger, endeavor to screw the snake into spiral coils; before he can produce a single turn, the whole of the long and slender body will roll over as rigidly as if the attempt had been made upon a straight stick.

When we call to mind the anatomical structure of the skull, the singular density and thickness of the bones of the cranium, strike us as a special provision against fracture and injury to the head. When we contemplate the still more remarkable manner in which these bones are applied one over another, the superoccipital, overlapping the exoccipital, and the parietal overlapping the superoccipital, the natural segments being sheathed one within the other, the occipital segment within the parietal one, we cannot but discern a special adaptation in the structure of serpents to their commonly prone position, and a provision of the dangers to which they were subject from falling bodies, and the tread of heavy beasts. I might enumerate many other equally beautiful instances of design and foresight,—the whole organization of the serpent is replete with such—in relation to the necessities of their apodal vermiform character; just as the snake-like eel is compensated by analogous modifications amongst fishes, and the snake-like centipede amongst insects.

But what more particularly concerns us in the relation of the serpent to our own history, is the great and significant fact revealed by palæontology, viz., that all these ophidian peculiarities and complexities of cranial and vertebral organization, in designed subserviency to a prone posture and a gliding progress on the belly, were given by a beneficent Creator to the serpents of that early tertiary period of our planet's history; when, in the slow and progressive preparation of the earth, the species which are now our contemporaries were but just beginning to dawn; these, moreover, being species of the lowest classes of animals, called into existence long before any of the existing mammalia trod the earth, and long ages before the creation of man.

8. *Indiana Cave*, (New Albany Ledger, Ind.)—We are just informed by N. J. Coleman, Esq., who has recently visited the great Indiana cave, that another immense cavern has been discovered opening from the original cave, which in extent, curiosities, and mineral productions, far surpasses the old cave. Mr. Coleman discovered an aperture, just before reaching Jacob's Ladder, into which a large man could hardly enter, and desired the party which accompanied him to explore it. The guide and two or three of the party objected, as the aperture appeared to descend rapidly, and they feared they might meet with bad

air. By a little persuasion however, they were prevailed upon to make the exploration. With much difficulty they descended some forty feet, when to their great astonishment, they found themselves in an immense apartment. They immediately determined fully to explore the cave they had discovered. They found that this room opened into others, and these into still others, and that apparently, there was no termination to the cave. They followed the main passage some four or five miles according to their best calculation, when they were admonished by their lights that they must return. On their way back, they visited some of the rooms which they had passed, in which they had found large beds of epsom salt, in nearly a pure state. We are also informed that the cave contains fine specimens of saltpetre, plaster of Paris, alabaster, &c., of which the party procured many fine specimens.

It seems then, that Indiana has a cavern which far surpasses the Great Mammoth, as the last discovery in connection with the great Indiana cave will make it one of the largest in the United States.

It is about eleven miles from Corydon in a southwest direction, and about seven north of Leavenworth.

9. *On the Blue Licks Spring, Licking River, Ky.;* by Prof. Robert Peter, M.D., Transylvania University.—Saline, and saline sulphur-waters, are comparatively frequent in our blue limestone strata; but among all the springs of this nature, known at present on this formation, in Kentucky, none are as valuable and as remarkable, in many respects, as those of the lower Blue Licks.

The principal spring of this locality, from which the water submitted to analysis was taken, is situated near the banks of the Licking river, flowing out about twenty feet above low water in that stream. It rises in a hexagonal basin of stone which has been built for it, which is six feet two inches in diameter from one side to the opposite parallel one, and about five or six feet in depth. The quantity of water which flows out varies in different seasons. When the water for the present examamination was obtained, June 6, 1850, it was low in the spring and not running. The water in this basin was lowered about one foot by pumping out seventy six barrels,* in the course of three hours; and in the winter time the stream which flows out from it would probably fill a pipe three inches in diameter.

The temperature of this spring was observed by Major Richard Owen, Professor in the Western Military Institute located at the Blue Licks. In six observations, at different times on June 4th and 5th, the external air varying from 60 degs. to 76 degs. Fahr., the temperatnre of the water stood very constantly at 62 degs. This is about seven degrees above the mean temperature of this region, which is about 55 degs.; and it is probable that the temperature of the water in the basin had been somewhat raised by the external heat of the atmosphere. When flowing rapidly it may perhaps be found to approximate more nearly to the mean annual temperature.

On standing exposed to the air, the water becomes of a yellowish-green color, very perceptible in a white pitcher, or even in a white

* These barrels will not contain more than thirty gallons.

glass bottle. This color deepens on boiling the water,—but boiling does not cause it to appear in the recent water.

Besides sulphuretted hydrogen and carbonic acid which are dissolved in the waters or escape insensibly, streams of bubbles of gas are continually rising through the spring and breaking into the atmosphere. Some of this *gas*, carefully collected for me by Maj. Owen, in bottles prepared for the purpose, was submitted to analysis, and found to consist mainly of nitrogen, mixed with about 4·5 per cent. of carbonic acid gas, containing only a trace of sulphuretted hydrogen.

The analysis of the water was performed in the chemical laboratory of the Medical Department of Transylvania University, at Lexington, with the assistance of Mr. A. Schue, of the Western Military Institute.

The composition of the Blue Lick water; according to this analysis, is as follows; calculated both in 1000 grains of the water and in the wine pint of 7·680 grains, viz.:

Specific gravity 1·007.

Gases	in 1000 grains.		In the wine pint.	
	Grains.	Cubic inch.	Grains.	Cubic inch.
Sulphuretted hydrogen gas,	0·03947	0·1086	0·303129	0·834048
Free carbonic acid gas,	0·3547	0·76	2·724096	5·8368

The former is in the proportion of about 1·36th the volume of the water and the latter about 1·5th the volume.

Saline contents	in 1000 grains.		In the wine pint.	
Carbonate of lime,	0·3850000	grains.	2·9568000	grains.
Carbonate of magnesia,	0·0022065	"	·0169459	"
Alumina, phosphate of lime and oxyd of iron,	0·0058330	"	0·0447974	"
Chlorid of sodium,	8·3472930	"	64·1072102	"
Chlorid of potassium,	0·0226690	"	0.1740979	"
Chlorid of magnesium,	0·5272000	"	4·0488960	"
Bromid of magnesium,	0·0009394	"	0·0302546	"
Iodid of magnesium,	0·0007340	"	0·0056371	"
Sulphate of lime,	0 5533300	"	4·2495744	"
Sulphate of potash,	0·1519190	"	1·1166738	"
Silicic acid,	0·0179400	"	0·1377792	"
Loss,	0·2819861	"	2·2158335	"
Whole saline contains,	10·3000000		79·1040000	

The water also contains traces of oxyd of manganese, and apocrenic and crenic acids.

Taking the data above given as to the quantity of water which flows out at this spring, we find that it emits 678 gallons in the day of twenty-four hours. Supposing the saline matters to constitute but one per cent. of the water, the amount brought out in one hour would be more than 58 lbs. avoirdupois. But say that 50 lbs. an hour is the proportion, and the quantity will amount to 438,000 lbs. per annum. The specific gravity of common salt being 2·257, this quantity in solid lump would contain about 310 cubic feet, or be enough to form a cube of salt nearly seven feet on a side! And yet the water flows on without any

sensible diminution of its saltness. Whence is all this saline matter obtained? Is there, imbedded in the deeper strata of the blue limestone, an immense layer of rock salt, derived from the original ocean, under which the rock was deposited?

10. *Wingless Bird*, (Proc. Linn. Soc., Dec. 17, and Athenæum, No. 1209.)—Mr. Westwood called the attention of the Society to the existence of a wingless bird on Lord Howe's Island,—an island situated between New Holland and Norfolk Island. This spot had been accidentally visited by Capt. Poole of the East India Company's service; who considering it a favorable spot for colonization, had induced six Irishmen and their wives and families to settle on it. The place is now one of constant resort for the supply of water and provisions to the South Sea whalers. As no Government has owned it, this island is at present the property of Capt. Poole. It is of considerable extent, and has on it two high hills which can be seen at a distance of sixteen leagues at sea. On this island Capt. Poole had discovered the bird in question. It is about the size of a rail,—and is considered by the settlers as good eating. Mr. Westwood thought the announcement of the existence of this bird—which was not previously known to exist in those regions—would be received with interest in connection with the discovery of the extinct wingless birds of New Zealand. No specimen has yet arrived in England,—but some are on their way.

11. *Vegetable Physiology*, (L'Institut, No. 878.)—MM. Cloës and Gratiolet operated in their experiments upon aquatic plants, as different species of Potamogeton, Naias, Ceratophyllum, Myriophyllum and Confervas. The following are some of their results.

a. Influence of light.—The disengagement of oxygen from the green parts of the plants is very rapid in full solar light, insensible in diffuse light, and null in darkness, and in the last condition *no* carbonic acid is disengaged, contrary to an old opinion but now for some years correctly understood. With glass of different colors, the effect was greatest with colorless glass, and diminished in the order, red, green, blue.

b. Influence of temperature.—The decomposition of carbonic acid by aquatic plants exposed to light under a temperature of +4° C., does not commence until the temperature is raised to 15° C., and has its maximum at 30° C.; and if the plants are in a temperature of 30° C., then on its reduction, action continues even to 10° C. This result corresponds with Chevreul's on the circulation and ascension of the sap of plants.

c. Influence of the composition of the surrounding waters.—In river water, deprived of air by ebullition and containing only carbonic acid in the same proportion as the waters of the Seine, the water being frequently renewed, the decomposition is at first active, but afterwards diminishes and ceases after four to five days; and by this time the green color of the plant has become paler. At first the gas produced is mixed with some nitrogen, the quantity of which goes on diminishing, so that when the decomposition ceases, the air disengaged is almost wholly pure oxygen. The total volume of the nitrogen disengaged is much more considerable than the volume of the plant, and on submitting this plant to elementary analysis, it is found that for equal weights, it contains much less nitrogen than a portion of the same plant not sub-

jected to the experiment. The facts show that in the act of growth in submerged plants, nitrogen proceeds from the decomposition of the elements themselves of the plants; that consequently a resupply is necessary and consequently nitrogen free or combined is essential to the life of the plant. In the experiments instituted by Cloës and Gratiolet, a ten-thousandth of ammoniacal salts dissolved in water always proved injurious. The decomposition of carbonic acid diminished and ceased after some hours; whence the conclusion that the plant assimilates directly nitrogen in solution in water. They have also found that whatever may be the position of the leaves of Potamogeton in the water, carbonate of lime is decomposed by the superior surface of the leaves and never by the inferior. They have also ascertained that the oxygen produced by the decomposition of the carbonic acid has a definite course—that it descends invariably from the leaves towards the roots. Thus when a stem of a Potamogeton is placed horizontally in water, the emission of the gas always takes place by the section nearest the root end of the plant.

12. *Anæsthetic Action*, (L'Institut, No. 886.)—M. Aran has made experiments on the anæsthetic action of certain agents used as an external application to the skin, and has found that the best material for this purpose is chlorated chlorohydric ether. The sesquichlorid of carbon may also be used, but whilst the ether operates effectually in a few minutes, at least two hours are required to produce insensibility with the sesquichlorid. To produce the desired effect, from 15 to 30 drops of the pure chlorated chlorohydric ether suffice; they are put upon the part in pain, or upon a piece of linen cloth which is to be immediately applied to this part, and the contact is maintained by a bandage; and quickly the pain is relieved. A pomatum of this ether may also be employed consisting of 4 grammes to 20 of suet; or if of the sesquichlorid of carbon, 4 of this agent to 30 of suet; it may be used either with friction or without. The insensibility is not simply cutaneous, for it gradually extends to the parts beneath.

The chlorated hydrochloric ether is obtained by the action of chlorine on hydrochloric ether, by which, compounds containing chlorine in increasing proportions are formed, isomerous with the series of bicarburets of hydrogen, and identical with the same series in the density of the vapor for corresponding compounds. It is a colorless liquid, of an ethereal aromatic odor analogous to chloroform, and a sweetish and even peppery taste at times; hardly soluble in water, but wholly so in alcohol, sulphuric ether, and most of the fixed and volatile oils. It is without action upon paper of tournsol; is not inflammable; has a variable density and a variable point of ebullition, oscillating between 110° and 130° C., showing that the material is rather a mixture of several ethers than a single simple substance. All the chlorated chlorohydric ethers have the same anæsthetic properties, and they cannot be separated completely from one another.

13. *On Telegraphs, and on Gutta Percha as a means of insulation and a material for models;* by Prof. C. G. Page, (Report to Commissioner of Patents, Patent Office Report, for 1849, p. 405.)—A variety of inventions under this head, have been presented to the office, most of them based upon the electro-magnetic telegraph. Prominent among

these is the electro-chemical telegraph. Two patents have been granted for inventions of this kind, one of which has already gone into practical operation, to a considerable extent. These inventions were adjudged by the office to interfere with each other, and upon a hearing, priority of invention decided in favor of one of the parties. Upon appeal however, to the usual tribunal, it was decided that the alleged interference did not exist, and patents were ordered to be issued to both parties. The whole case was one of unusual interest, involving many intricate and important questions, and although the whole proceeding was prior to your accession to the office, yet the leading features are doubtless by this time familiar to you. The parties, Sam'l F. B. Morse and Alexander Bain, came into the contest for priority of invention upon unequal grounds, the former being a citizen of the United States, and the latter a foreigner. It was held by your predecessor in office, that under the law a foreigner could not go behind his foreign patent or printed publication for evidence of his invention, and upon reference of this subject to the Attorney General, the opinion of the commissioner was confirmed. It was also held that in a contest for priority of invention, the sealing of a foreign patent was not to be taken as proof of invention, and that proof of enrolment was alone adequate. On the appeal to Chief Justice Cranch, the parties appeared by counsel, who occupied some days in elaborate argument. It was, I believe, the first trial of appeal from the office, had in open court, and the whole case has been faithfully reported and printed at the expense of one of the parties. The report will be read with much interest by inventors and professional men.

The operation of the electro-chemical telegraph depends upon the chemical re-agency of the galvanic current. Marks or stains are made upon paper through which the galvanic current is made to pass, the paper being first saturated with some neutral or other salt, and moistened at the time to give it sufficient conducting power. The advantage claimed for this over the electro-magnetic telegraph, is that it may be worked with much greater rapidity. In the electro-magnetic telegraph a signal is made by the development of electro-magnetism, and the consequent movement of a small bar of iron, both of which operations require appreciable time. In the chemical telegraph the production of the stains or marks is commensurate with the passage of any portion of the galvanic current; for, according to the best authorities, the current could not pass through the salt without decomposition. The change of colors, as indicated to the eye, may not be so sudden as the transit of the current, but if it should not be so in fact, it becomes so practically, as the marks are not required to be seen at the instant of decomposition. I am not informed upon this point, but it is immaterial; the practical distinction between the chemical and electro-magnetic telegraph being this, that as it requires time to change and discharge an electro-magnet, and also to overcome the inertia of moving parts, there must be a limit in practice to the rapidity of making signals, while in the electro-chemical telegraph, the limitation would depend upon other causes, and the rapidity of action would probably far exceed the ordinary mechanical facilities for communicating signals. With a view to avail himself of this greater capability of this telegraph over the other,

one inventor has pattented a means of preparing and transmitting communications much more rapidly than the ordinary manipulations with the key. To accomplish this, strips of paper are perforated by machinery, in such a manner that the perforations may correspond to the signs representing the letters, figures, or words, and by means of these perforations and the intervening spaces, or whole portions of the paper, the circuit is broken and closed with as great rapidity as a slight spring pressing upon a strip of paper can be made to act. It is only necessary that the motion of the paper at the other end of the line which is to receive the communication should move with a corresponding rapidity. In practice it has been found that the rapidity of execution is much less than it should be theoretically; but nevertheless it is far greater than with the electro-magnetic telegraph. With this, as with all the plans for telegraphs hitherto undertaken, a difficulty of some importance has been encountered, from the imperfect insulation of the wires, although great pains have been taken to render the insulation as complete as practicable, and several patents have already been taken out for telegraphic insulators. As the insulated supports for the wires have to sustain a considerable weight, they must be made of a corresponding strength; and, moreover, as they have been made the sportive targets of lawless boys, and objects of less wanton though more malicious mutilation by mischievous men, it has been found necessary to give a due share of attention to strength and safety in this respect, and in so doing some sacrifice of insulating properties have been thus far deemed necessary. A curious result follows from this want of insulation. If it be assumed that the air is impervious to galvanic electricity, all that can return to its source between two distant stations, without travelling the whole distance, must pass down each post on the line, and can reach the post only through the substance of the insulating material employed, or along its surface in case it should be moist. A greater amount of electricity will pass down those posts nearest the station where the battery is in operation, and at the extreme end of the line only a feeble portion will pass through the instruments. The consequence of this has been, that upon the conductors being moistened upon their surfaces, the instruments at the distant stations would work with unequal power, and occasion much embarrassment. This difficulty is in some measure remedied, by having batteries at each end of the line, or at every station, although the defective insulation still exists for each. I am inclined to think however, that the air, when loaded with moisture, is a conductor of galvanic as well as of mechanical electricity, as indicated by my experiments, several years since, with the immense copper roof of the Patent Office, forming a great galvanic plate of upwards of 20,000 square feet of surface. If it is sufficiently so to be of practical value, it is obvious that entire insulation of telegraphic wires will be difficult to accomplish.

The *crossing of rivers* and large bodies of water, by means of submerged wires, does not seem yet to have been attained, and the chief obstacle thus far is imperfection in the methods of insulation. The plan which I proposed several years since appears to be worthy of trial. It consists in using a local circuit and battery of quantity at each river or body of water. The galvanic current employed on the main

routes are of small quantity and high intensity; hence a slight defect of insulation in a submerged wire would be productive of a great loss. But by using a current of quantity and the lowest possible intensity, to be set off by a local magnet, I am inclined to think that a single wire laid in the river with the most ordinary preparations for insulation, would be effectual in establishing connection between the terminations of the great line on opposite sides of the river or other body of water. It has long since been proposed to connect the eastern and western continents by means of telegraphic wires laid down in the depths of the ocean, and lately the proposition has been revived with a venturesome and true American spirit. It does not appear in any way impracticable to stretch a wire from the American continent to England; and in the waveless depths of the interminable waters, the wire would be more secure from depredation than on *terra firma*. From its weight it would sink beneath the realms of the living monsters, and lie far out of reach from the ruthless hand of mischief or speculating avarice. But the insulation of such a wire is a thing not easily conceived of, in the present state of our knowledge. Besides the mechanical niceties required to obtain a complete insulating covering for the wire, we should have to contend against the corrosive action of the sea water, and this too, at a point where its greater density would exalt its chemical agency.

Much has been expected and promised from *gutta percha* as an insulator, but we have not been long enough acquainted with this curious substance to test its value for this purpose. It is indeed a most excellent electric and insulator, but I have seen several instances of its decomposition when exposed to air and moisture, and some cases of its entire destruction when in thin sheets. I have been recently informed that the decay of thin sheets of gutta percha is attributed to caustic materials used in preparing it; however this may be, I have seen supports for telegraphic wires made from the pure gum, undergo in one season decomposition to such a depth as to form a bibulous mass upon its surface, and materially impair its non-conducting property. It resists, however, to a remarkable degree the action of strong acids, and may be used with great convenience for funnels, syphons, &c., for transferring and holding even strong nitric acid. It may not be out of place here to mention its unfitness, when in very thin sheets, for models of patented inventions. During the past year a patent was granted for a surgical instrument, an essential part of which was a sac of gutta percha. In the course of a few months the entire sac had disappeared, having crumbled into powder.

American Indicating Disc Telegraph.—An instrument under this name has been patented, which presented some ingenuity and novelty in the mechanical arrangements, and also in the selection and use of signals. It is an optical or indicating telegraph, as its name purports, and in this particular, must yield to the recording telegraphs. The signs are indicated by the figures 0, 1, 2, 3, 4, these being the only symbols used. These stand for the vowels, and the remaining letters are represented by combinations of these figures. The figures are arranged in four sets, upon the face and near the circumference of a disc, which revolves by means of a novel internal escapement, which is moved by a lever attached to the armature of an electro-magnet. Its language is less complex than that of other indicating telegraphs.

Pen Telegraph.—When Prof. Morse's telegraph was first essayed in this city, it recorded the signs upon a moving fillet of paper by means of a pen charged with ink, the pen being supplied from a reservoir or fountain. It was found difficult to regulate the flow of the ink, more especially as the motion of the pen was apt to *throw* the ink, as it was termed, and the pen was accordingly dispensed with, and a contrivance substituted, by which marks corresponding with those made by the pen were indented upon the fillet of paper. This required some mechanical force, and it became necessary to have a local registering magnet, as it is called, of some power to supply this force. In the new pen telegraph the inventor has ingeniously reversed the order of Morse's telegraph, and moves the paper to the pen which is kept stationary, thus obviating the difficulty of throwing the ink and requiring a slighter force to move the paper than is now required to indent the paper. The pen is also fed by an ingenious contrivance. A lever or arm carrying a feeder which dips into a fountain of ink, is operated at the requisite intervals so as to move up to the pen and deposite upon a proper amount of ink, and then retire again to the fountain to recharge. This arm carrying the feeder is actuated by the clock work which is used to move the fillet of paper. It was thought that this invention would save the necessity of using a receiving magnet, and that the telegraphing might be performed directly by the use of one magnet merely to move the paper to the pen. If, however, it fails to supersede the receiving magnet, it can have no advantage to recommend its use.

14. *On the Purification of Coal Gas;* by Mr. Laming, (Proceedings of the Society of Arts, April 24th, 1850; from Chem. Gazette, June 1st, 1850, p. 218.)—The ordinary method of purification by lime is confessedly very imperfect, as it removes but very little of the ammonia, and the refuse is very offensive in its odor and from its great quantity becomes a nuisance. The advantages of the new process are that it removes every trace of ammonia and sulphuretted hydrogen, and that the materials do not require to be periodically renewed. It consists in a mixture of oxyd of iron and chlorid of calcium, which the author prepares by decomposing a saturated solution of muriate of iron with lime or chalk and then mixing it with fine coal or saw-dust to give the mass the necessary permeability. The iron in the mixture becomes rapidly peroxydized from its porosity and from the spontaneously elevated temperature of the mass.

On placing this, instead of lime, in the purifiers, the impure gas containing sulphuretted hydrogen, in part or wholly combined with ammonia besides carbonic acid, converts by the action of the sulphuretted hydrogen the peroxyd of iron into sulphuret of iron and water, while the liberated ammonia forms a carbonate with the carbonic acid, and the latter salt with the chlorid of calcium forms salammoniac and carbonate of lime. When no more oxyd of iron and chlorid of calcium remain undecomposed, the mixture is exposed for a time to atmospheric air, which converts the sulphuret of iron into sulphate; this reacting with the carbonate of lime yields sulphate of lime and carbonate of iron which by the atmospheric oxygen is rapidly converted into hydrated peroxyd with the escape of carbonic acid.

The mixture now differs from the original only in containing in place of the chlorid of calcium a sulphate which acts in precisely the same way. The regeneration of the used materials is effected in an hour or two and the author has already repeated it fifteen successive times. It becomes at last necessary to wash out the salt of ammonia, when the material regains all its pristine force.

By this process all impurities, even the sulphuret of carbon, are removed, with a large portion of carbonic acid, while the increase of the illuminating power is estimated at eight per cent. The cost of materials is slight, while the impurities are converted into merchantable articles, and the wear and cost of apparatus is reduced to a minimum.

These results have been verified by experiments at Paris and successfully carried out on a large scale at the gas works at Westminster.

T. S. H.

15. *On the Asphaltic Coal of New Brunswick;* by C. T. Jackson, (Proc. Bost. Soc. Nat. Hist., April, 1850, p. 279.)—On the 16th of last March, Henry W. Fuller, Esq. of Boston, sent me a box of specimens of a new kind of fuel recently discovered in New Brunswick. It was regarded as cannel coal of a peculiar kind.

This substance proved to be a very beautiful variety of asphaltum. It is jet black, glossy, and free from smut. It breaks with a broad conchoidal fracture like obsidian, and presents a brilliant surface.

It is a little softer than rock salt, which scratches its surface. Its specific gravity is 1·107.

It softens and melts when exposed to heat in close vessels. When inflamed it does not run, but burns freely with a bright yellow flame and a little smoke. Heated in a glass flask, it gives off an abundance of bituminous liquid analogous to petroleum, and leaves a very light and bulky coke of a brilliant black color and very porous. When exposed to heat in a covered platinum crucible, an abundance of carburetted hydrogen gas is given off, which burns with a large and brilliant yellow flame, having a high illuminating power.

The asphaltum is but slightly acted upon by alcohol or by ether, yielding a little yellowish matter, which is obtained by evaporation of the solution. Oil of turpentine dissolves a considerable quantity of the asphaltum, forming a varnish such as is used by engravers.

Weighed portions of the asphaltum were taken for analysis, and on being heated in a covered crucible so as to expel all the volatile matter, the coke remained and was weighed. The results of two trials gave,—

1st.	2nd.
58·5 of volatile matter.	58·8 of volatile matter.
41·5 of coke.	41·2 of coke.
100·0	100·0

The coke obtained was burnt on a platinum tray, placed in a red-hot muffle, and left 0·47 per cent. of ashes, of a deep reddish brown color, consisting of peroxyd of iron with a little oxyd of manganese, and silica, and alumina.

The discovery of this valuable fuel so near to our borders is a matter of congratulation. The bed is stated to be four to six feet in thickness, and if it holds out for any considerable extent, it must supply an enormous amount of fuel. This substance is particularly valuable for the production of gas for illumination. It is also the best fuel for steam engines, and is particularly well adapted for the use of locomotive steam engines on railroads.

I have not visited the spot where this asphaltum is found, but, having seen it associated with gypsum from Dorchester, N. B., am led to believe that it occurs above the coal formation of New Brunswick.

[The facility with which this asphaltic coal melts down in the gas retorts has hitherto, we are informed, been an obstacle in the way of its use.—Eds.]

16. *Shooting Stars of August*, 1850.—M. Quetelet states that according to the facts observed, the number of shooting stars per hour on the evening of the 9th of August, was about 60 for Brussels; on the evening of the 10th, 111 for Brussels, 180 for Markree, Ireland, and 58 for Rome. The direction was the same for all these places.

17. *Lalande Medal*, (Athenæum.)—The Academy of Sciences at Paris has awarded the Lalande medal to M. de Gasparis for his discovery of the planet Hygeia in April, 1849. The prize for 1850 was shared between Gasparis for his discovery in November of two planets, and Mr. Hind for his discovery on the 13th of September of the planet Victoria, (Clio.)

18. *Academy of Natural Sciences of Philadelphia. Extracts from the Reports of the Librarian and Curators for the year* 1850, (Proc. Acad., v, 127, 129, 132.)—"The additions to the Library, of all descriptions, during the present year (1850) amount to 2965, this number being more than double that of 1849, and far exceeding the ratio of any previous year since 1834. The subjoined table has been prepared in the ordinary form, presenting the number of volumes, pamphlets, and works in parts or numbers, on each subject.

Subject.	Number of volumes.	Periodicals in parts, numbers, &c	Pamphlets.	Subject.	Number of volumes.	Periodicals in parts, numbers, &c	Pamphlets.
General Natural History,	151	40	36	Brought over, - -	744	244	395
Mammalogy, - - -	12	1	14	Physical Sci. and Chemistry,	10	1	10
Ornithology, - - -	78	35	27	Medicine, - - -	3	. .	15
Entomology and Crustacea,	191	23	56	Trans. and Proceed. of Soc.,			
Ichthyology and Herpetolgy,	9	4	19	Journals, Annals, &c., &c.,	622	334	8
Conchology and Helminthology, - - - - -	48	56	52	Voyages and Travels, -	147	136	7
Geology and Mineralogy,	105	21	57	Geography, - - -	26	. .	2
Botany, - - - - -	9	9	7	Dictionaries of Arts and Sci.,	110	. .	. .
Anatomy and Physiology,	141	55	127	Bibliography, - - -	23	. .	17
				Miscellaneous, - - -	34	. .	77
	744	244	395		1719	715	531

Of the whole number 2965, there have been contributed by authors 74; by editors 18; by members, correspondents, and others 109; by societies and corporations 113; by Dr. Wilson 2493; by Mr. Edward Wilson, of Wales, 153; by the U. S. Treasury Department 5 (charts)."

"The increase in the cabinet during this year, will be briefly noticed under the head of each respective department.

Mammalia.—In this class, the Academy has been greatly enriched by the addition of the collection of Dr. J. K. Townsend, made by himself in the Rocky Mountains and Oregon, consisting of 37 species, 56 specimens, in skin, in a good state of preservation. These were liberally presented to the Society by Dr. Townsend. Most of them are the specimens from which the species were originally described, and many of them are exceedingly rare in natural history collections, and a few are unique. Among them are two specimens of the gigantic wolf of America, *Lupus gigas*, lately described by Dr. Townsend in the Journal of the Academy.

We have also received skins of twenty species of mammalia, of Europe, Asia, Africa, and Australia, from W. E. Strickland, Esq., of England, through Dr. Wilson.

Another addition of great value was made by Dr. T. B. Wilson, consisting of one hundred specimens from the collection of the Prince of Canino, C. L. Bonaparte, being the originals of the species figured and described in the Fauna Italica.

We are also indebted to Capt. W. McMichael for 7 species, 8 specimens, of animals from Van Diemens Land.

Besides the above there were presented to the Society ten species from various sources.

Aves.—We have received during the year 71 bird skins, of which 51 are from Van Diemens Land, presented by Capt. W. McMichael; 10 from China, presented by Capt. John Land; the remainder from various localities, presented by Dr. E. J. Lewis, and others.

The valuable Des Murs collection of Bird's eggs, containing 1281 species, mentioned in the last report of the Curators as a deposit, has since been presented to the Academy by Dr. Wilson.

To Mr. Samuel Ashmead we are indebted for a donation of 38 species, 48 specimens, of American bird's eggs.

There were also presented by various individuals, principally members of the Society, 15 species of nests, and 23 of eggs, from different localities.

Reptilia.—Of reptiles there have been received 65 species, 80 specimens, besides numerous American duplicates, principally from Dr. McCartee, of Ningpo, China; Capt. John Land; Mr. Sandwith Drinker, of Hong Kong, China; and Mr. Ashmead.

Pisces.—In ichthyology, the cabinet has received, rather unexpectedly, a large and very valuable collection, presented by Dr. T. B. Wilson, consisting of 767 bottles containing fishes in alcohol, and 177 dried specimens of the latter, formerly belonging to Prince C. L. Bonaparte, and being the originals of the descriptions and illustrations of the Fauna Italica.

From other persons we have received eleven species of fishes, principally American.

Mollusca.—In this department there have been presented 107 species of shells, from various localities, principally by Mr. Ed. Verreaux, of Paris, Dr. McCartee, of China, and Messrs. E. T. and Chas. W. Wilson.

Insecta.—A fine collection of Brazilian insects, consisting of 484 species, 981 specimens, has been added to our cabinet through the lib-

erality of Henry Bond Dewey, Esq., of Para, Brazil, through Dr. Henry Bond, of this city.

To Dr. McCartee, also, we are indebted for the gift of 120 species, 216 specimens, of Chinese insects. Other collections have also been received, but without definite number, in exchange or by donation, principally from Drs. Heerman, Townsend, and Watson.

The collection of insects of the Academy is arranged in boxes in the form of large quarto volumes, with glass on the two sides, so as to permit the objects to be viewed from above and below without disturbance. The Lepidoptera now arranged amount to 979 species, 1692 specimens.

Crustacea, Myriapoda, and Arachnida.—A large collection of Crustacea has been presented to the Academy by Dr. Wilson, consisting of 381 species, 749 specimens, from all parts of the world.

There have been received, also, nine species from different persons.

Ten Spiders and three Myriapods were presented by Dr. McCartee, of Ningpo.

Echinodermata.—Of Echini and star fishes we have received 21 species, 41 specimens, chiefly from Mr. Edward Wilson, and Messrs. Harwick and Argent, of London."

The Report continues with statements of additions correspondingly large, in the departments of Comparative Anatomy, Botany, Palæontology and Mineralogy.

President for 1851, Samuel George Morton, M.D.; *Vice Presidents*, J. Price Wetherill and Robert Bridges, M.D.; *Corresponding Secretary*, John Cassin.

OBITUARY.

John James Audubon died on the 27th of January, 1851, aged seventy-six years, at his residence on the banks of the Hudson. Audubon was born in Louisiana, and was the son of an admiral in the French navy. In his sixteenth year, he went to France for his education, and was there instructed in drawing by the celebrated David. In 1824 he became acquainted with Lucien Bonaparte, who suggested the publication of his drawings of birds already very numerous. This took him to Europe, and after a while his splendid work on the Birds of America was in progress. After his return to this country, he was off on new explorations, and visited the Floridas, Maine, Canadas, Labrador, and other regions. In 1842 he commenced the publication of the Quadrupeds of America, a work of unsurpassed magnificence, in which he was aided by Dr. Bachman.

Prof. H. C. Schumacher, the astronomer of Altona, and the distinguished editor of the *Astronomische Nachrichten*, died Dec. 28, 1850, in the 71st year of his age. His long and industrious life has been successfully devoted to the advancement of astronomy and the allied sciences.

VI. Bibliography.

1. *Patent Office Report, for* 1849. Part I, Arts and Manufactures, 624 pp., 8vo, with plates, Washington, 1850; Thos. Ewbank, Esq., Commissioner of Patents.—From this valuable document, we learn that the number of patents applied for in 1849 was 1955; of patents issued

during the year, 1076; of rejected and suspended applications (part from preceding year) 1409. About 750 patents expired during the year. The amount remaining in the Treasury to the credit of the Patent Fund, January 1st, 1850, was $169,505, and during the year $50,000 had been drawn out for the erection of wings to the building. This volume is illustrated by a series of 9 plates, affording a beautiful example of Chromo-lithography from the press of P. S. Duval, Philadelphia. There are six plates of the organs of motion of water-animals in illustration of a valuable paper by the Commissioner on the forms of paddles and propulsion of steamers. There is much good sense in the remarks on a household branch of patents, (*Atmospheric Churns*,) reported by Prof. C. G. Page, which we here cite.

The subject of churns belongs to the class of agriculture, which class will be reported upon by the Examiner having that branch in charge. In consequence of an unequal apportionment in the number of cases, I have had during the year forty-nine applications transferred to my desk, and among them twenty-one applications for churns. Most of these were styled atmospheric churns, and since I have been in the Patent Office I have never witnessed such a *mania* upon any one invention. The first impulse seems to have been given by the grant of a patent for a churn in which there were boxes upon opposite sides of a common revolving dasher, so situated that as the dasher revolved, the box containing the cream, with its open mouth downwards, carried down a portion of air to the bottom of the churn and as the mouth of the box inclined upwards, the air escaped from it through the mass of the cream, while the box itself filled with the cream, and as it came out and revolved in the upper part of the churn above the cream, that contained in the box was thrown out and scattered into spray. Both the descent and size of the box occasioned a commingling of the air and cream, and answered the purpose of agitation as well perhaps as any form of dasher. In the report of last year the rationale of atmospheric churns was given. It may be well to repeat that the introduction of air plays no chemical part in the production of butter, its separation from cream being merely a mechanical process. And although the atmospheric churns operate to a considerable advantage, yet it is by means of more thorough agitation, which is increased greatly by the diffusion of air throughout the cream. As each portion of air rises through the cream, it forms a bubble upon the surface before it escapes, and in some of the atmospheric churns, where the dasher is constantly submerged, the whole mass of cream is converted into a complete mass of foam. From the success of such a churn as that above named in producing butter in a shorter time than other churns, a most enthusiastic speculation was at once commenced upon atmospheric churns, and inventive powers were racked to modify, mystify and contort a simple principle, with a view of producing novelties rather than improvements. From the immense number of churns used throughout the country, great gains could not fail to follow the monopoly of a new and superior churn. The golden prospects have tempted many into the field, and it is quite curious to observe in this instance the natural drift of intellect, bringing the workings of independent minds into one common channel. A patent was granted for one species of atmos-

pheric churn, but before this could have been known far beyond the walls of the Patent Office, two other inventors, each and all from different parts of the country, had laid claim to the identical improvement. One was from Ohio, the second from Illinois, and the third from Vermont. An interference was accordingly declared, and no sooner had the decision been made in favor of the patentee, than three other inventors were found pressing their claims to the same invention. It presents an unprecedented case in the history of the Patent Office of seven persons, each a *bona fide* inventor, all claiming the same thing and about the same time, and all from distant portions of the country. This improvement consists simply in boring a hole through the entire length of a common upright churn dasher, and placing a valve either at the bottom or top of the dasher. This valve opens downwards, and when the dasher is raised with such rapidity that the cream cannot follow up, the air rushes down through the valve under the dasher, and upon the downward stroke the air is passed out laterally and escapes by the side of the dasher and up through the mass of cream. It requires not a very quick motion and but little force to effect this, and the agitation is most complete. A full sized model was exhibited in the office showing the operation with clear water only. Upon agitating the dasher, the water appeared as if in intense ebullition. Another peculiarity belongs to this churn worthy of note. In the common churn, the dasher has to be raised out of the cream at each stroke and plunged down with some force, and as this scatters the cream, it is necessary to cover the churn tightly and allow the dasher to play through a small hole in the centre of the cover; but in this atmospheric churn the dasher is kept always under the surface of the liquid, and consequently there is no splashing of the cream, and the cover may be left off with safety, and enable you to watch the operation. A strong recommendation is its simplicity, and as one of the inventors stated he could alter any common churn dasher to this principle for twenty-five cents.

Prior to this simple device for introducing air, several complicated inventions had been patented, and many more made and presented to the office to effect the same purpose. In truth this invention at first was not considered patentable; but after the exhibition of its actual operation by one of the inventors, a different view was adopted and a patent ordered to issue. As atmospheric churns were not new, the ground was taken that the use of any known means of introducing air was not patentable. The ground of action is correct in itself, but did not appear applicable in the case after a personal explanation from the inventor, and an exhibition of the operation and result of his invention. The patentability of an invention frequently turns upon a nice point, and inventions the most novel are sometimes the most worthless, while again others least novel in appearance, bearing the similitude of common and unpatentable devices, are most valuable and important in practice. Simplicity is the essence of true invention, and it is often interesting to see after a multitude of complicated inventions to attain a certain end, some discerning, or perhaps fortunate inventor, demolish a whole labyrinth of combinations, and arrive at the result by means so simple as almost to rob invention of its charms. Such means as one would suppose should have been the first and not the last resort. Mingled with

the surprise are often times feelings of regret and chagrin by his competitors, that they had not discovered this most obvious path. To such cases the words of Milton are quite apropos:

> "The invention all admired, and each how he
> To be the inventor missed; so easy it seemed,
> Once found, which yet unfound, most would have deemed
> Impossible!"

Such cases are the most embarrassing to your examiners. If measured by the length and breadth of novelty, little is to be found, while yet the measure of utility has in no way been made to appear. But to return to the churns.

A modification of the last named churn has been patented, in which the hole in the dasher at the lower part was large enough to contain a solid plunger, fitting loosely within the dasher, which acts the part of a second valve. There have been also several patents granted for ingenious forms of rotary atmospheric churns. These inventions crowded upon the office so numerously, that they were examined with the most rigid scrutiny, and on several occasions, actual demonstrations by experiment of making butter, was required of the applicants, to satisfy the office that the inventions claimed justified their pretensions to be real improvements. In most of these cases, the results were unfavorable to the inventor; but in some, patents were ordered to issue. On one occasion an experiment was performed (humorously characterized by a bystander as a "churn race,") between a patented and a new churn, in which they both came out alike, making butter from new milk in two minutes and a half. Such a rapid separation of the butter, however, is by no means desirable, although this is the general aim of these improvements. We have it upon the highest chemical authority, that butter made so rapidly is not likely to be as good as that which is made slowly.

2. *Pictorial Atlas of Fossil Remains*, consisting of Colored Illustrations selected from Parkinson's "Organic Remains of a Former World," and Artis's "Antediluvian Phytology;" with Descriptions by G. A. Mantell, Esq., LL.D., F.R.S., &c., xii, 208 pp. 4to, with 74 plates, containing nearly 900 figures. London. 1850. H. G. Bohn.—This elegant work, while embracing a large part of what gave value to the volume of Parkinson, has a much higher character and importance, and is more available to the geologist. The excellent plates of Parkinson, the last of which appeared just forty years since in what may be styled the infancy of geology, are accompanied with the modern scientific names of the species, and descriptive remarks. In this part of the labor of preparation, Dr. Mantell acknowledges the assistance of J. Morris, Esq., F.G.S., distinguished in the department of Palæontology. The frontispiece to the volume is a beautiful plate of the foot of the famous giant bird of New Zealand, the Moa, the remains of which have been obtained in a state of remarkable perfection by Walter Mantell, Esq., of Wellington, N. Z., son of Dr. Mantell, as mentioned in former numbers of this Journal. The engraving is a superb specimen of lithography and exhibits well the structure of this part of the skeleton; it is taken from a recent memoir by Dr. Mantell on this wonderful bird. The introductory part of the volume contains

an account of the colossal New Zealand birds. The volume closes with "Supplementary Notes" by Dr. Mantell, which add greatly to the interest of the volume. They embrace observations on The Fossil Bears of Caverns;—The Structure of the Belemnite and Belemnoteuthis;—The New Zealand Fossil birds;—Botanical Arrangment of Fossil Vegetables;—Fossil Cephalopoda, Nautilus, Ammonite, &c.;—The Carboniferous Deposits or Coal Measures;—Structure of Mineral Coal;—On Fossil Corals;—Cuvier's Discoveries at Montmartre;—Fossil Edentata; Animal Remains in Flint and other siliceous nodules;—On Foraminifera;—Fossil Elk of Ireland;—Fossil Infusoria and Infusorial Earths; —The Mosasaurus;—Fossil Reptiles of the Wealden;—Silicification or Petrifaction by flint;—On Stigmaria, Sigillaria, with figures, illustrating the stumps and roots.

3. *On the Pelorosaurus, an undescribed Terrestrial Reptile* whose remains are associated with those of the Iguanodon and other Saurians in the strata of Tilgate Forest, in Sussex; by G. A. MANTELL, Esq., F.R.S., &c. From the Philosophical Transactions. Part II, for 1850. London: 1850.

Supplementary Observations on the structure of the Belemnite and Belemnoteuthis; by G. A. MANTELL, Esq., F.R.S. From the Phil. Trans., Part II, 1850. London: 1850.

The memoirs, whose titles are here given, have appeared within the past year, in the Philosophical Transactions. As an abstract has already been given in this Journal* a farther notice is not necessary. The illustrations are in the best style of lithography especially those of the various bones of the Pelorosaurus, whose forms are brought out with a clearness of detail and a boldness of tint that exhibits the hand of an artist.

The Dorsal dermal spine of the Hylæosaurus, recently discovered in the strata of Tilgate Forest, is the title of another memoir by Dr. Mantell in the Philosophical Transactions for 1850. On an examination, microscopally, in 1848, of sections of the spine, the internal structure was shown to be identical with that of the dermal scutes of the Hylæosaurus, presenting "long, straight, spicular fibres, decussating each other in all directions and representing as it seems the ossified ligamentous fibre of the original corium." Recently (in 1850) a specimen has been obtained in the Tilgate Forest, by Dr. Mantell exhibiting the proximal end or base of the spine and showing the nature of its connection with the animal and proving that his conclusion was right with regard to the nature of the spine. If perfect, the length would be 15 inches. The parts show that while in existing lizards the dermal appendages are flexible and cartilaginous, in certain fossil reptiles they are rigid osseous spines.

4. *A Treatise on Trigonometry, Plane and Spherical, with its application to Navigation and Surveying, Nautical and Practical Astronomy and Geography, with Logarithmic, Trigonometrical and Nautical Tables, for the use of Schools and Colleges.* A new edition with extensive additions and improvements; by Rev. CHARLES W. HACKLEY, S.T.D., Prof. Math. and Astr. in Columbia College. 8vo. 372 pp. text and 238 of mathematical tables. New York. 1851. G. P. Putnam.—The author

* Vol. ix, 2nd ser., pp. 438, 439.

has prepared a convenient and thorough treatise on trigonometry in its various departments. While it is full in the exposition of principles and formulas, it is unusually complete in its account of mathematical and astronomical instruments, and in practical information respecting the various applications of Trigonometry, as in Surveying, Navigation, Geodesy and Nautical Astronomy. He has happily digested into a short systematic treatise the principal operations employed upon the coast survey of the United States, and has explained the use of the magnetic clock in recording observations, and entered into the subjects of canal and railroad engineering, and the construction of maps. The work is therefore well fitted for the practical surveyor and navigator, as well as for the scientific student; and it is made convenient for the nautical man by tables of logarithms, a traverse table, table of meridional parts, and others, which are mostly printed from the plates of Bowditch's Navigator, by permission of G. W. Blunt the proprietor of that work. The author has also introduced Prof. Chauvenet's paper on unlimited triangles, and has given a new method of deducing Napier's analogies by means of the Gauss equations.

5. *Review of Chemistry for Students*, adapted to the courses as taught in the principal Medical schools of the United States; by J. G. Murphy, M.D. 328 pp. 12mo. Philadelphia: 1851. Lindsay & Blakiston.—The author has prepared this work in order to furnish the student with a condensed review of the principles and facts of chemistry that may be a convenient accompaniment to a course of lectures, and serve for an easy revision of the subject. Although not offered as a text-book it has the same range in a briefer way. We are not satisfied with the illustration of repulsion, by a Prince Rupert's drop, and see a want of precision in some of the definitions. But the work is still a good one, and may well answer the purpose for which it is intended. The changes in the formation of compounds by complex decompositions are exhibited to the eye, and the facts under each head are systematically and clearly brought out.

6. *The advantages of a Geological Survey of the State of Missouri;* by H. A. Prout, M.D. 30 pp. 8vo. St. Louis. 1851.—The state of Missouri, although noted for its mineral wealth, is still unexplored by the geologist. Dr. Prout in this pamphlet has set forward the various advantages of an immediate survey, in a clear and striking light, and we add our endorsement to all he has said, and our earnest hope that the state may go forward in a work economically so profitable, and at the same time so honorable to her intelligence and love of science. It is a fact of some meaning, that in recent discourses upon the half century just ended, the progress of science has been the great theme. If science has carried forward the world with a progress so wonderful, a nation is not wasting money in the contributions that may be made toward any of its departments. Missouri has her mines of lead, copper, zinc, cobalt, iron; material for glass and porcelain; sources of salt, alum, copperas; and what other undeveloped treasures we know not. But even without such inducements to survey thoroughly her borders and obtain a just knowledge of her resources, the advancement of science in its highest and purest signification, should be a sufficient incentive.

7. *Reports on the Geology and Topography of California;* communicated to the Senate by the Secretary of War. Ex. Doc., No. 47, 31st Congress, 1st Session.—This volume includes a Report on California by Mr. P. T. Tyson; a Report of General Smith; of Lieut. Talbot to General Smith; of Prof. J. F. Frazer on minerals forwarded by Gen. Smith; of Gen. Riley; of Lieut. Ord to Gen. Riley; of Lieut. Derby of his survey of a portion of the valley of the Sacramento; of Lieut. R. S. Williamson of the reconnaissance made by Capt. W. H. Warner of a route through the Sierra Nevada by the Upper Sacramento. Mr. Tyson's Report occupies the larger part of the volume and contains much valuable information. In the Report of Lieut. Derby, the height of the Sacramento Bute* is given as follows: for the north peak 2,843 feet above the plain; for the south 1,841 feet.

Prof. Frazer gives the following analysis of the lignite of the Cowlitz, Oregon; sp. gr. 1·314.

Loss of weight at 212° (water &c.),	4·9
" " at red heat (bitumen),	49·5
" " by combustion (from carbon),	42·9
Ash residuum,	2·7
	100·0

A drab colored compact limestone, (sp. gr. 2·63,) from Monte Diavolo near San Francisco afforded Mr. A. Muckle his assistant,

Carbonate of lime,	97·8
Carbonate of magnesia,	*trace*
Oxyd of iron and alumina,	1·4
Silica,	0·3
Water,	0·25
	99·75

8. *Note Géologique sur les Terrains de Sabero, et de les Environs dans les Montagnes de Leon* (Espagne); par D. Casiano de Prado, Ingenieur des Mines, suivie d'une description des Fossiles de ces terrains, par M. Ed. de Verneuil. (From the Bulletin of the Soc. Geol. of France, 2nd Ser., vii, 137. Jan. 21, 1850.)—This memoir treats mainly of the coal-bearing rocks of the district of Sabero, Spain, which, although like the true carboniferous formation, de Verneuil is inclined to refer to the upper devonian. These beds extend over the region occupied by the villages of Sabero, Saelices, Olleros, Sotillo, Llama and Veneros, on both banks of the Esla, and are prolonged towards Colle and Las Bodas where they pass beneath Cretaceous rocks. The direction of the beds is in the main from east to west, and the inclination when not vertical is towards the south with slopes of 45 to 70°. Verneuil observes that whatever difference of opinion may exist as to the coal of Sabero, and also that of Ferrones and of Arnao (Asturias), there can be but one opinion about the limestones which accompany it; they are the same limestones with those of Viré, Izé, Gahard near Rennes, the harbor of Brest, and of Nehou (Manche) and of Ferques in France, and belong, as the fossils indicate, to the devonian formation. This important memoir is accompanied by figures and descriptions of the fossils by Verneuil.

* For a sketch of the Bute, see this Journal, 2nd Ser., vol. vii, p. 259.

9. *The Doctrine of the Unity of the Human Race examined on the Principles of Science;* by JOHN BACHMAN, D.D., Prof. Nat. Hist., Coll. of Charleston, S. C., &c. 312 pp. 8vo. Charleston: 1850.—It is of much interest to science that Dr. Bachman has entered the field on this important question. His known scientific learning, a result of extended personal observation as well as thorough study, will give weight to his opinions and confidence to his statements. He brings a large amount of facts to sustain the doctrine of the unity of the human race in its strictest sense.

We must still acknowledge that this subject has but just begun to be investigated; and we hail with pleasure all contributions relating to it, from whatever direction and whatever their bearing. The result ultimately established will be truth: and any restlessness or ill temper shown in the progress of the debate will prove only an exhibition of weakness or cowardice. Facts alone, carefully studied, and pursued in all their ramifications, are the proper means of combating error, and these should be thrown into the general fund with that exalted trust in the divine origin of truth which subdues all personal feeling and ennobles both science and religion. The latter has nothing to lose, and both have much to gain from honest, sober investigation.

10. *Contributions to Conchology*, No. 8, pp. 125—152; by Prof. C. B. ADAMS.—This number of Prof. Adams's Contributions contains descriptions of new species of Partula, and Achatinella (Sandwich Islands); and of Marginella, Buccinum, Valvata, Planorbis, Ancylus, Truncatella, Helicina, Cyclostoma and Stoastoma from Jamaica.

11. *The Western Agriculturalist*, A Monthly Journal devoted to Agriculture, Political Economy, Arts and Manufactures, &c., Edited by W. W. MATHER, Corresponding Secretary of the Ohio State Board of Agriculture. Vol. I, No. I, January, 1851, 32 pp. large 8vo, Columbus, Ohio.—It is a high recommendation of the Western Agriculturalist, that it has the editorial labors of Prof. Mather, so well known for his able geological researches. Prof. Mather's qualifications are not merely scientific; for, as he observes, during the last ten years he has been a practical farmer in Ohio, and cleared the land for a home in a forest that the axe had not touched. The Board of Agriculture of Ohio, unsolicited, appointed Prof. Mather to the office of Corresponding Secretary of the Board and Agricultural Chemist of the state, and by urgent request, he has consented to edit an agricultural Journal. The numbers will present the recent developments of science in their bearing on agriculture, and also whatever of a practical character can be of avail in the household, the dairy, on the farm, or in the workshop. Domestic economy and domestic manufactures will receive attention as well as agriculture and its associated departments.

12. *Boston Journal of Natural History.* Vol. VI, No. 2. 296 pp. 8vo., with 4 plates.

I. ASA GRAY: Plantæ Lindheimerianæ. Part II. An account of a collection of plants made by F. Lindheimer in Texas in the years 1845–6 and 1847–8. pp. 141—240.

II. W. O. AYRES: Description of a new species of Polypterus, from West Africa; with a plate. The species is called P. palmas, from Cape Palmas, its locality. pp. 241—246.

III. HORATIO R. STORER: Observations on the Fishes of Nova Scotia and Labrador, with descriptions of new species. pp. 247—270, illustrated by plates.*

IV. N. M. HENTZ: Descriptions and figures of the Araneides of the United States, (concluded.) pp. 271—295.

C. T. JACKSON, M.D.: An address delivered before the Plymouth County Agricultural Society, at their Annual Exhibition in the Town of Bridgewater. 30 pp. 8vo. *Boston.* 1850.

Prof. J. BROCKLESBY: Views of the Microscopic World: designed for general reading and as a hand-book for classes in natural science. 146 pp. 16mo, illustrated with numerous engravings. *New York*, 1851. Pratt, Woodford & Co.

R. HUNT SNELLING: The Photographic Art Journal, a monthly periodical; vol. i, No. 1. January, 1851. *New York.*

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE: Occultations visible in the United States during the year 1851, computed by John Downes, at the expense of the fund appropriated by Congress for the establishment of a Nautical Almanac. 26 pp. 4to. *Washington*, 1850.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE: Ephemeris of the Planet Neptune, for the year 1851; by Sears C. Walker. 10 pp. 4to. *Washington*, 1850.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE: Researches relative to the Planet Neptune; by Sears C. Walker, dated Washington, April 10, 1848, 60 pp. 4to.—The memoir treats of (I) Abstract of Events connected with the discovery of Neptune, the Progress made in its Theory and the completion of the Theory of Uranus; (II) Detailed account of the two ancient places of Neptune, observed by Lalande in May, 1795; (III) Computations confirming the authenticity of Lalande's Printed observations; (IV) Subsequent Researches on the Orbit of Neptune.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE: Aboriginal Monuments of the State of New York; by E. G. Squier, A.M. 188 pp. 4to, with 14 plates. 1851.

SMITHSONIAN INSTITUTION: Fourth Annual Report of the Board of Regents of the Smithsonian Institution, for the year 1849. 64 pp. 8vo. *Washington*, 1850. Senate Document Misc. No. 120. 31st Congress, 1st Session.

Abbildungen u. Beschreibungen neuer u. seltener Thiere u. Pflanzen in Syrien u. im westl. Taurus gesammelt v. Th. Kotschy, herausg. v. den D. D. Fenzl, Heckel und Redtenbacher, 2 Lfg. Imp. 4to, (25 lithog., 107—1058 pp. of text in large 8vo.) *Stuttgart.* 1849. 2⅔ *dollars.*

F. BECKER: Geognostische Skizze von Hessen. 66 pp. large 8vo. *Darmstadt*, 1849. ½ *dollar.*

BEITRÄGE ZUR PFLANZENKUNDE DES RUSSISCHEN REICHES. Hrsg. v. der Kaiserl. Acad. der Wissenschaften. 6 Lfg. large 8vo, 62 pp. *St. Petersburg*, 1849. *Leipzig*, Voss.

Dr. A. BLATTMANN: Mikroskopisch-anat. Darstellung der Central-organe d. Nervensystems bei den Batrachiern m. besond. Berüchsicht. von Rana esculenta. Large 8vo, 95 pp. and 1 lithog. in 4to. *Zurich.*

Prof. Dr. H. BURMEISTER: Die Labyrinthodonten aus dem bunten Sandstein v. Bernburg, zoologisch geschildert 1 Abth; Trematosaurus, iv and 71 pp. with 4 lithog. in 4to. Berlin, 1849. G. Reimer. 3½ *dollars.*

Dr. W. EBEL: Geographische Naturkunde od. Grundzüge einer algem. Naturgeschichte der drei Reiche m. physiognom. Schilderung der Erdoberfläche f. Studirende, Schulmänner u. Gebildete überhaupt, 1 Abth. Plan der Geog. Nat., 2 Abth.; Geog. Nat. v. Island, xvi and 446 pp. 8vo, with 14 lithog. *Königsberg.*

Dr. H. W. DOVE: Monats-isothermen. 32 pp. 4to, with 3 lith. *Berlin*, 1849. D. Reimer, 2½ *dol.*

Dr. E. HARLESS: Ueber d. Zahnbau v. Myliobates. 36 pp. 4to, with 3 lithog. Munich. From the Transactions of the Bavarian Academy.

J. J. HECKEL: Abbildungen u. Beschreib. neuer Thiere. Beiträge zur Kentniss der foss. Fische Oesterreichs, Abh. I, Chirocentrites, Pimelodus, Saurorhamphus, Amphisyle, Meletta, Clupea, Lepidopides, Lepidotus. Fol. 44, pp. with an Atlas of 15 lithog. *Vienna*, 1849.

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* The new species described are mentioned on p. 129 of this volume.

Dr. G. A. W. Herrich-Schäffer: Schmetterlinge v. Europa. Revision u. Supplemente zu J. Hübner's Sammlung europ. Schmetterlinge. 41 and 42 parts. Large 4to. 48 pp. of text, and 20 colored lithog. *Regensberg.* 3⅙ *dol.*

Dr. Martius: De Genera et species Plantarum etc. Fasc. ix. 256 pp. imp. fol. and 26 lithog. 1849. Uncol. 34 *dol.*; col. 45⅔ *dol.*, for fasc, i—ix uncol., 182 *dol.*, col. 314⅔ *dol.*

Dr. A. Th. v. Middendorff: Malacozoologia Rossica. Abth. ii and iii, 281 pp. 4to, with 21 lithog. *St. Petersburg.* 1849. *Leipzig*, Voss.

Dr. R. A. Philippi: Abbild. u. Beschreib. neuer od. wenig gekannter Conchylien, iii vol. 6 Lfg. with 6 lithog., and 26 pp., 4to. *Cassel*, 1849.

Prof. Dr. H. Stannius: das peripherische Nervensystem der Fische, anat. u. physiolog. untersucht. iv and 156 pp. Large 4to. *Rostock*, 1849. 3½ *dol.*

J. H. C. F. Sturm: On Leptodirus, genus of the family of Scydmænides. 8 pp. 8vo, with 1 col. plate. *Nuremberg*, 1849. ½ *dol.*

Maur. Willkomm: Recherches sur l'organographie et la classification des Globulariées. 32 pp. 4to, with 4 col. plates. *Leipsick.* 2 *dol.*

Zeitschrift der deutschen geologischen Gesellschaft, 2nd vol. 4th part. Large 8vo, 64 pp. with lithog. *Berlin.* 6 *dol.*

Dr. Albert Wigand: Intercellularsubstanz und Cuticula,—a Treatise on the structure and metamorphosis of vegetable cell membrane. vi and 130 pp. 8vo, with 2 plates. *Braunschweig*, 1850. 1½ *dol.*

G. Ritschl: Flora des Grossherzogthums Posen, im Auftrage des naturhist. Vereins zu Posen. xxxii and 291 pp. 8vo. *Berlin*, 1850. 1½ *dol.*

Proceedings of Bost. Soc. Nat. Hist.—1850.—p. 305, On certain species of Pike; *Z. Thompson.*—p. 307, Snowfly and Larves; *J. S. Davis.*—p. 309, New species of U. S. Exploring Expedition Shells (Genera Avicula, Crenatula, Perna); *A. A. Gould.*—p. 312, On Cottus variabilis as distinct from C. Groenlandicus; *Mr. Ayres.*—On Ibis guarauna in New England; *Dr. Cabot. July.*—p. 319, Remarks on Naviculæ; *Dr. Burnett. August.*—p. 321, Red oxyd of Zinc and Franklinite of New Jersey; *C. T. Jackson.*—323, A bullfrog found with a mouse in his stomach, and others feeding on spiders.—p. 324, Pot holes in New Hampshire; *C. T. Jackson.*—p. 324, Relations of the order of Parasites (Lice) to different Faunæ; *Dr. Burnett. September.*—p. 328, Observations on bones of the Zeuglodon; *Dr. Wyman. October.*—p. 332, Two new species of Philine; *Mr. Stimpson.*—p. 335, Tumor from an Ixodes; *Dr. J. M. Warren.*—p. 335, Remarks on the age of the Sandstones of the Connecticut river and Lake Superior Regions, &c.; *C. T. Jackson.*—p. 336, Ibid; *Prof. Agassiz.*

Proceedings of the Acad. Nat. Sci. Philadelphia, Vol. V. *August.*—p. 66, Fossil Mammalia from Missouri; *D. D. Owen* and *J. G. Norwood.*—p. 67, New birds of the genera Paradisea, Pastor and Buceros; *J. Cassin. September.*—p. 81, On the word species; *Dr. Morton.** *October.*—p. 85, On the antiquity of some Races of Dogs; *Dr. Morton.*—p. 90, On two new Mammalian Fossils; *J. Leidy.*†—Meteorological Table from Chagres to New York; *R. C. Taylor.*—p. 96, Contributions to Helminthology; *J. Leidy.*†—p. 98, On the development of the Gordius aquaticus; *J. Leidy.*†—p. 100, Two new species of Infusorial Entozoa; *J. Leidy.*†—p. 100, On some Nematoid Entozoa; *J. Leidy.*—p. 103, Descriptions of some new birds of the Genera Parus, Emberiza, Carduelis, Myiothera and Leuconerpes in the Collections of the Academy; *J. Cassin. November.*—p. 107, Descriptions of three Filariæ; *J. Leidy.*† *December.*—p. 119, On the nettling organs of the Hydra; *J. Leidy.*—p. 121, On some species of Fossil Mammalia; *J. Leidy.*†—p. 122, On embalmed heads of Egypt; *Dr. Morton.*—p. 124, New Genera and Species of Vermes; *J. Leidy.*—p. 126, On a new American Duck; *J. Cassin.*

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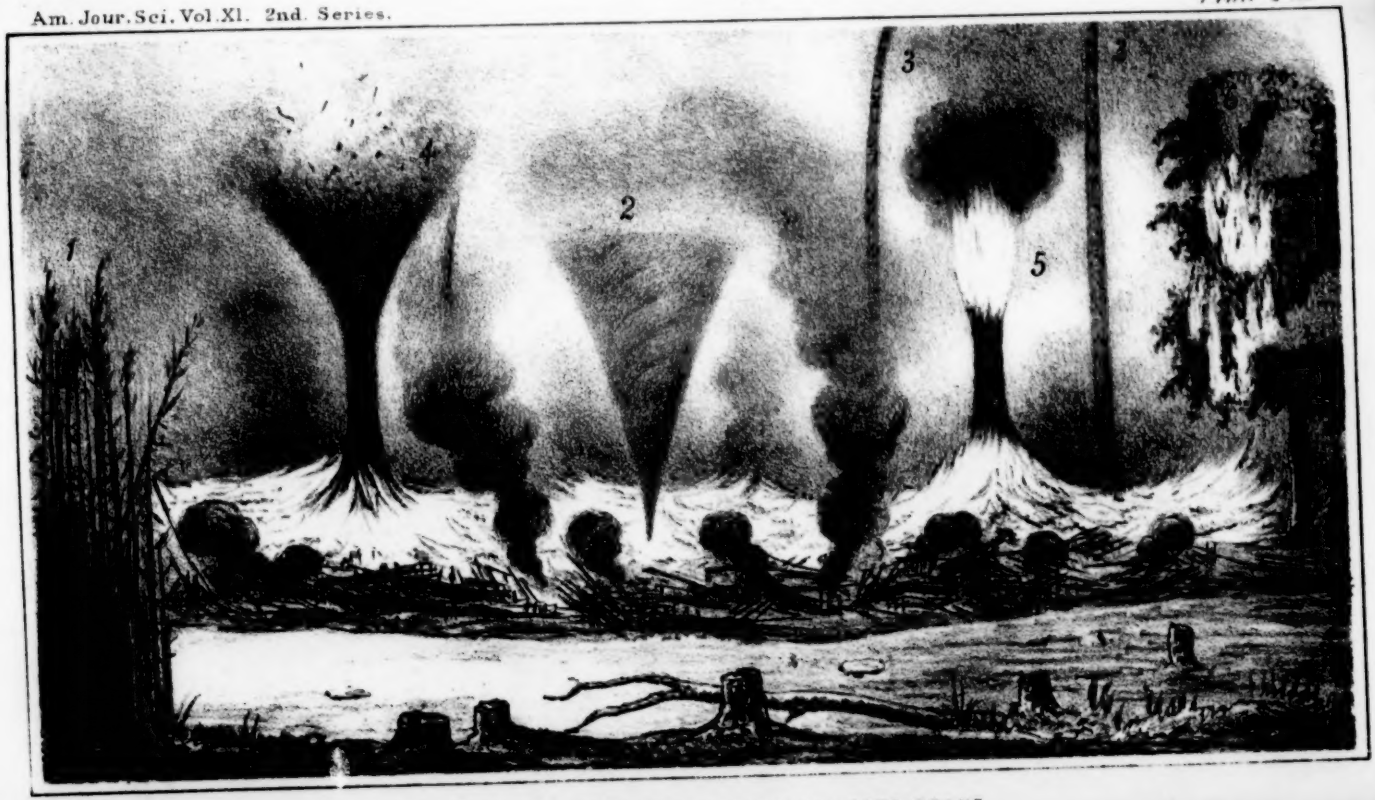
* See this volume, p. 275. † Ib. p. 274.



WHIRLWINDS FROM THE BURNING OF A CANE BRAKE.